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Gordon Moore Updates Moore's Law

Dr. Gordon Moore, Chairman Emeritus, Intel Corporation, shows that Moore's Law will continue evolving the PC platform for another 20 years.

Top Stories

PC Evolution Accelerates at Intel Developer Forum

Attendees at the industry's premier hardware developer conference get implementation tools and training on the latest platform technologies directly from Intel's top architects and engineers.

Delivering the Instantly Available PC

The hardware building blocks are here today for developers to design fully power managed PCs that "instantly" wake-up on demand in 1998.

PC 98: Keeping the PC Platform Balanced

Intel's PC 98 architect discusses the top three hardware technology implementations in the PC 98 System Design Guide as showcased at IDF.

Introducing Intel Platform Performance Tools

Intel makes available internally developed tools to ease technology adoption and platform performance evaluation and tuning.

Implementing Wired for Management Throughout the Enterprise

Leading PC OEMs are now delivering Wired for Management enabled platforms and leading software suppliers are demonstrating that end-to-end WfM solutions are deployable across the enterprise.

Platform News and Information

***** Check out our Platforms, Technologies, and Events pages *****

Every month we cover the latest developments in platform initiatives and technologies. Our "Platforms" pages provide news on the latest trends and initiatives for the business, home, mobile, server and workstation platforms. Our "Technologies" pages give you quick and detailed information on the industry status of specific platform technologies, from the emergence of the Accelerated Graphics Port (AGP) to the latest advances in Intel microprocessors, memory, Audio, USB, 1394, DVD, Power Management, and PC 98. Our "Industry Events" page keeps you up to date on upcoming industry gatherings targeted at the platform and peripheral developer.

Technology News

This department is your source for the hottest technology and product announcements, white papers, design guides, specifications, tools and developer events available to the industry.

- Instantly Available PC Power Management Design Guide Now Available
<http://developer.intel.com/design/power/pcpower.htm>
- Power Supply '98 Delivers Dual Mode Power Supply Specification
<http://developer.intel.com/pressroom/archive/releases/CN92997A.HTM>
- Audio Codec (AC)'97 Specification Updated to 2.0
<http://developer.intel.com/pc-supp/platform/ac97/>
- 100MHz SDRAM Specifications Now Available for Download
<http://developer.intel.com/design/pcisets/memory/index.htm>
- New Low Pin Count Specification (LPC) eases migration to ISA-less Systems
<http://developer.intel.com/design/pcisets/lpc/>
- Intel Announces New Line of Platform Performance Tuning Tools
<http://developer.intel.com/design/ipeak/index.htm>
- Intel's Application Launch Accelerator to be included in Windows*98
<http://www.intel.com/pressroom/archive/releases/cn93097b.htm>
- Mobile Power Initiative & Guidelines Introduced by Intel
<http://developer.intel.com/design/mobile/intelpower/>
- Industry Unveils Intel-Based Servers with I2O® Technology
<http://www.intel.com/pressroom/archive/releases/io100797.HTM>
- New Mobile Pentium® Processors with MMX™ Technology Provide 40% Increased Performance and 50% Lower Power
<http://developer.intel.com/design/mobile/>
- Intel Create & Share™ Camera Pack Brings Creativity PC to End Users
<http://www.intel.com/createshare/crshare.htm>
- New DVD Whitepapers Available from Intel Developers Forum
<http://developer.intel.com/solutions/tech/dvd.htm>

Reader Services

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<http://developer.intel.com/solutions/>

We want you to consider *Platform Solutions* as your personal information resource for the Intel architecture platform.

If you can help us make it better, or if you have a comment, question or a specific topic you would like to see covered, we want to hear from you. Please take the opportunity to send us an email with your specific feedback or request to:

platform_solutions@ccm.sc.intel.com

If you do not want to receive this mailing in the future, please send an email to: platform_solutions@ccm.sc.intel.com with "unsubscribe" in the body of the message.

On behalf of all of us at Platform Solutions, welcome to the future of the PC platform!

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Feature:

The Continuing Silicon Technology Evolution Inside the PC Platform

*by Dr. Gordon E. Moore
Chairman Emeritus
Intel Corporation*

The outside of the typical desktop PC platform has not changed a great deal since the original design was introduced by IBM* in 1981. The basic ergonomics of a large box with monitor on top and keyboard in front has remained remarkably constant over the past 16 years. Inside the PC platform, however, the electronics has evolved rapidly and this is about to create a dramatic change in the PC usage model. The PC is maturing from a universally adaptable, "one-size-fits-all" system into a wide range of targeted appliances designed to solve specific user applications. The fuel behind this expanded and changing role is Intel's relentless performance increases of the microprocessor.

I first observed the "*doubling of transistor density on a manufactured die every year*" in 1965, just four years after the first planar integrated circuit was discovered. The press called this "Moore's Law" and the name has stuck. To be honest, I did not expect this law to still be true some 30 years later, but I am now confident that it will be true for another 20 years. By the year 2012, Intel should have the ability to integrate 1 billion transistors onto a production die that will be operating at 10GHz. This could result in a performance of 100,000 MIPS, the same increase over the currently cutting edge Pentium® II processor as the Pentium II processor was to the 386! We see no fundamental barriers in our path to Micro 2012, and it's not until the year 2017 that we see the physical limitations of wafer fabrication technology being reached.

You can observe the beginnings of a role-change in the PC platform today. Some applications will continue to drive for maximum available processor performance but others will use the processor capabilities in different ways. Mobile systems, for example, are able to slow the processor down to conserve battery life yet still deliver incredible performance to the user. A PC platform targeted at home entertainment could use the processor performance to decompress an MPEG-2 video stream in software. This reduces the cost of the platform by removing special decompression hardware, making the system more affordable to a broader market. I expect to see rapid growth in all PC platform application areas in the next few years.

The Focus section in this issue of Platform Solutions delves deeper into the challenges of Micro 2012 and discusses the R&D efforts that Intel is employing to remove the barriers to delivering this improved capability to the PC platform. This material was originally presented at the Intel Developer Forum (IDF), and a webcast is available for your listening pleasure at the IDF site. The last 16 years of the PC platform have been filled with exciting innovations. The next 20 years promises to be even more exciting for the user experience, and it's all made possible by Intel's silicon technology leadership.

About the Author:

Dr. Gordon E. Moore is Chairman Emeritus of Intel Corporation. Gordon co-founded Intel in 1968 and was CEO from 1979 to 1987. He is the originator of the now legendary Moore's Law, named after him in 1965, for which Intel silicon technology has tracked for over 30 years.

For More Information:

To find out more about how Moore's Law is changing the PC platform, visit the **Focus** section in this month's *Platform Solutions* newsletter (<http://developer.intel.com/solutions/focus.htm>).

For more information on the Intel Developer Forum, read the **Top Story** in this month's Platform Solutions on *Pace of PC Evolution Accelerates at the Fall Intel Developer Forum* (<http://developer.intel.com/solutions/issue/stories/idf.htm>).

To see and hear a webcast replay of **Gordon Moore's IDF keynote** presentation, visit the IDF web site (<http://developer.intel.com/intel/idf.htm>).

Top Stories:

Pace of PC Evolution Accelerates at the Fall Intel Developer Forum

According to the industry experts who were on hand, "it was a tremendous opportunity to interact with technologists from all the major PC companies throughout the world," said David Mooring, Vice President & General Manager, Personal Computer Division, Rambus Inc.*

The first Intel Developer Forum (IDF) was an opportunity for leading hardware developers from virtually every leading PC manufacturer and Independent Hardware Vendor (IHV) not just to hear about, but to actually see, demonstrations of the latest implementations of the newest hardware technologies.

Attendees gained a hands-on familiarity with the latest advances in Intel architecture platforms—and seized a valuable opportunity to establish and strengthen personal working relationships with top Intel and industry technology experts.

Hands-on Training

Technology drives the pace of evolution of the PC. The pace accelerated on September 29 in San Francisco as hundreds of hardware developers representing the computer industry's leading companies gathered at the Fall '97 IDF.

The event, which represented the first of a series of bi-annual IDF conferences, offered an unprecedented opportunity for PC developers to spend three days focusing on the latest technologies driving the hardware platform.

Gordon Moore Updates Moore's Law

Continuing improvements in processor performance show no signs of slowing down, according to Intel Chairman Emeritus Gordon Moore, who set the tone for the IDF with a keynote presentation on "Moore's Law" and its profound implications for product developers.

Moore presented a live image, transmitted from Intel headquarters in Santa Clara, California, via ProShare® video conferencing, of a Pentium®II processor made with Intel's currently cutting-edge .25micron chip production technology. In the high-resolution focused ion beam image, individual atomic layers could be counted and identified.



Figure 1

Dr. Gordon Moore Gives an Update on Moore's Law

"In the next several years we get to some finite limits, but not before we go through five generations," Moore told his audience. According to one study, the physical limitations of wafer fabrication technology could be reached by the year 2017. "That's well beyond my shift," Moore quipped, "so someone else can do it."

IDF attendees came ready to learn the details of implementing the latest technical specifications—in some of the fastest changing frontiers of computer technology—for desktop, mobile and server platforms. They came away armed with an arsenal of new knowledge, tools and collateral support that will help speed the development of new products integrating the latest advances in a spectrum of technologies—Enterprise manageability, host-based interactive desktop graphics and DVD, CPU performance, 100 MHz SDRAM memory technology, AGP graphics, I/O and IEEE 1394 connectivity, mobile platforms, high-volume servers, PC Theater audio and video technologies, desktop power management, and PC 98 System Design Guide implementations.

64 Presentations on 10 Technology Tracks

The theme of Fall '97 IDF was "Beyond the Spec" and the event lived up to its promise. Attendees had access to a total of 10 hot technology tracks and were provided with 64 implementation-focused presentations by Intel's top platform architects.

- Attendees spent three days working with Intel experts in "hands-on" training sessions that moved beyond specifications to practical product implementation. They saw dozens of live demonstrations of the latest PC technologies in action.

"The Fall '97 IDF was great for engineers. I'm looking forward to bringing back more of my engineers next year," said Keith Thomas, Engineering and Technology Leader for Gateway 2000*.



Figure 2
*Attendees, along with a surprise visitor!,
view a Host-Based DVD Demo at the Technology Showcase*

- They received implementation design guides, SDKs, PDKs, and performance optimization tools, in addition to whitepapers and specifications. Each attendee received three CD-ROMs filled with collateral material.

"Others in the industry should look to IDF for the types of information that will help bring products to market faster," said Robert Brummer, Sr. Director Strategic Marketing, PC Products Division, Cirrus Logic Inc.*

- They made one-on-one contact with Intel architecture experts and received first-hand knowledge of where the technology is heading in 1998.

"IDF was like the old Tech Forum only better! It helped us develop a technology vision for the next year and a half and saved us a lot of technical and marketing research," said Henry Quan, Vice President Corporate Marketing, ATI Technologies Inc.*



Figure 3
*Developers collaborate with Intel's architects
at the informal Tech Talk sessions.*

- They had the opportunity to network with Intel executives and develop valuable professional contacts with Intel architects and other developers.



Figure 4
*Attendees interact with Dan Russell, Intel Director of Platform Marketing.
At the VIP dinner, Intel executives and fellows held round-table discussions.*

"IDF gave us a chance to talk to Intel's architects and express our concerns about technology directions, let them know where they're doing well, where they can improve, and make sure we're all collaborating effectively," said Tim Sullivan, Senior Systems Engineer, Dell Computer Corporation*.

Look for the Next IDF in February 1998

Intel would like to thank everyone who helped make Fall '97 IDF an outstanding success. The stage is now set for the **next IDF to be held February 17th 19th, 1998, in San Jose, California**. You can expect a similar highly focused technology training event where Intel provides its technology implementation knowledge to the industry and you get access to the top PC architects.

Intel continues to support the evolution of the hardware platform, and will continue to share the tools and training the industry needs to implement the latest technologies. Mark your calendars for February 17, 1998, and stay tuned to Platform Solutions for news about the next IDF. Continue to check back here for the latest news and information on the platform initiatives and technologies driving the evolution of the PC.

For More Information:

For more information on the **Fall 97 IDF**, including an overview of each technology track held along with webcast replays of each keynote presentation in NetShow* and RealPlayer*, please visit the IDF web site (<http://developer.intel.com/intel/idf/>).

You can also learn more about the key technology implications and announcements discussed at IDF by reading the other Top Stories in this month's *Platform Solutions*, Issue 2.

You will also find direct links to some of the key tools, guides and specifications announced at IDF in this month's Tech News section.

Delivering the Instantly Available PC ' in '98

*By Gary Solomon
Senior System Architect
Intel Corporation*

Enterprise manageability is a vital issue for IT professionals, and the Instantly Available PC has emerged as a key component of the industry's **Wired for Management** (WfM) initiative (<http://developer.intel.com/solutions/tech/wfm.htm>). Instantly Available PC building blocks are not only ready now, many leading PC OEMs are moving aggressively to implement them in platforms slated for volume shipment in 1998.

At the Fall '97 Intel Developer Forum, Intel demonstrated how the new Instantly Available PC Design Guide can be used to implement a robust power-managed PC. We also presented detailed discussions of how hardware could be designed to work hand-in-hand with software that supports Microsoft's* 'On Now' power management initiative.

User Benefits

Intelligent power management is equally important for desktop and mobile platforms. The 1998 desktop vision embodies a new generation of feature-rich, high performance PCs, with a set of robust power management capabilities:

- The PC will be power-efficient, in both its active and idle states;
- The PC will be "always connected" and available for communications and remote management, even when turned "off" (asleep);
- The PC will be instantly available to users and power management aware software applications, whenever it is needed.

The major benefit of the Instantly Available PC will be reduced total cost of ownership (TCO). For companies that are practicing LAN management, the greatest enemy of the LAN administrator is the "invisible client." This is because procedures that have been established for hardware and software inventory, software updates, software distribution and remote maintenance are simply "broken" when a networked machine is turned off.

When maintenance needs to be performed, IT will request that the machines be left on. This means wasted energy, and there will always be at least one machine turned off. For the machines that were turned off, the maintenance would either have to wait for the next scheduled procedure or occur during working hours. Both of these alternatives mean wasted time, productivity and money.

The Instantly Available PC assures superior LAN connectivity, including system resumption on a LAN event and programmable LAN filtering. In addition, business users will benefit from lower average power consumption (up to a 60 percent average power saving). Specifically, the Instantly Available PC should require less than 30 watts in an active (working) or standby state and less than 5 watts in its sleeping-while-communicating or sleep (off) state.

A New PC Usage Model Emerges

The goal of the Instantly Available PC initiative is to make power management a pervasive and user-transparent aspect of all new PCs. The usage models for the PC will be comparable to the consumer appliance model—like the TV set. This not only implies that the PC will provide users with instant access to the most recently used system state, it also means that users will no longer be required to make critical trade-offs between system performance, connectivity and efficient power management.

As the PC takes on other tasks such as answering telephones and handling faxes, we need our machines to be "Instantly Available" to us when we request them, similar to other electronic appliances. Instantly

Available PCs will enable video phones that will wait for incoming video calls from grandma and grandpa or a PC that will instantly wake up when your youngster puts in a CD-ROM.

Overcoming Problems With APM

Today's BIOS-controlled Advanced Power Management (APM) imposes some unacceptable trade-offs for users, with connectivity and PC performance often sacrificed in the name of power management efficiency. The shortcomings of this "non-intelligent" power management infrastructure now prevalent on the PC frequently lead users to disable the PC's APM features to maintain performance and full connectivity.

Delivering the Instantly Available PC

At the Fall '97 IDF, Intel renewed its corporate commitment to helping the industry make the Instantly Available PC a reality in volume products shipping in 1998. The Instantly Available PC has four key building blocks:

- Advanced Configuration and Power Interface (ACPI)-compliant operating systems and software (supporting Microsoft's "On Now" initiative);
- ACPI-aware Hardware and BIOS;
- Key features of Power Supply '98, a Dual-Mode Power Supply Specification;
- Hardware compliant with the PCI Bus Power Management Interface Specification, allowing the development of power-aware add-in cards.

The Fall IDF allowed Intel to present developers with an overview of ACPI, Power Supply '98 and PCI bus power management. Then we took developers "beyond the spec" with a detailed presentation of how to implement an Instantly Available power-managed PC. Developers came away from IDF with the tools and collateral support they need to implement Instantly Available PCs in 1998. The package included the beta version of the ultimate ACPI "tune-up kit"—the **Power Management Analysis Tool (PMAT)** (<http://developer.intel.com/solutions/tech/ipeak.htm>), the new Instantly Available PC Design Guide, the latest specification of Power Supply '98 (Rev. 0.5), and current information on ACPI implementation.

If you were unable to attend the Fall '97 IDF, you can download a copy of the **Instantly Available PC Design Guide** from Intel's developer site (<http://developer.intel.com/design/power/pcpower.htm>).

We hope to see you at the next Intel Developer Forum scheduled for February '98.

About the Author: Gary Solomon is a Senior Systems Architect in Intel's Platform Architecture Lab. He is a principal technical contributor working Intel's Desktop Power Management, and PC Audio initiatives.

For More Information:

For more information on the Instantly Available PC and its supporting developer materials and specifications, please visit the **Power Management** technology page in *Platform Solutions* (<http://developer.intel.com/solutions/tech/power.htm>).

PC 98: Keeping the PC Platform Balanced

by John Hyde

Platform Architect and PC 98 System Design Guide Editor
Intel Corporation

Intel has taken a leadership role with Microsoft* in establishing common definitions for PC platform initiatives and in advocating the adoption of open interfaces for the development community. The result of these efforts is the PC 98 System Design Guide, which consolidates a wealth of platform R&D and expertise into a single reference document designed to promote innovation and interoperability among PC OEMs and independent hardware vendors. Here's a look at some of the top PC 98 technology implementations identified by the guide and discussed at the first Intel Developer's Forum (IDF) on October 1, 1997.

At IDF, Intel presented in-depth design details on processor and memory performance, on I/O subsystem optimization and tuning, and on many other platform technology implementations. In addition, a number of PC 98-specific technology implementations were addressed. One of these was the ISA bus, which is a major impediment to keeping a modern PC balanced. Another was Audio, which is undergoing a transition from analog to a digital subsystem. And a third important technology discussed at IDF was Graphics subsystems—currently one of the fastest growing parts of the PC platform.

ISA Removal: The Bus Moves Forward

For many years, the ISA bus ruled as the reigning standard for the PC platform. In fact, this bus has remained unchanged since its 16-bit extension was implemented in the IBM* PC AT in 1983. Today, the performance of the ISA bus is adequate only for the simplest I/O functions—those requiring higher bandwidth have already moved to **PCI** (<http://www.pcisig.com>) or to **USB** (<http://developer.intel.com/solutions/tech/usb.htm>). At the present time, only two groups of developers are still focused on ISA: those with relatively simple I/O requirements, and those supporting legacy I/O implementations that provide DOS compatibility.

Conscious of the problems that ISA presents relative to attaining a balanced PC platform architecture, Intel is doing its part to help the industry move away from ISA and migrate to other buses. The preferred route for simple I/O applications is USB, but there has been some resistance to this approach due to the perceived complexity of a USB implementation. At IDF, Intel described a “cookbook” approach to USB migration and agreed to fully document the “recipe” in time for early deployment with Windows* 98.

Discussions also centered around the fact that legacy I/O devices require special attention. Intel has been working with Super I/O component vendors to define a **low-pin-count transition interface** which was announced at IDF (<http://www.intel.com/pressroom/archive/releases/CN092997.HTM>). National Semiconductor* and SMC* have announced product plans to support this interface in future versions of their chip sets. While some ISA devices are viable within the PC 98 timeframe, it's expected that ISA will be gone by the year 2000.

Audio: Going Digital

The diminishing influence of the ISA bus also has ramifications for **PC audio** (<http://developer.intel.com/solutions/tech/audio.htm>), most of which is still largely provided in the business computing arena using ISA implementations. While business audio is still analog, a dramatic shift is taking place toward encoded digital audio, because of its better fidelity and the enhanced experience it provides for users. As with other aspects of computing, greater bandwidth is required to deliver higher quality audio—particularly in the case of entertainment-oriented PCs, where digital audio solutions are poised to proliferate in the market.

While ISA is just barely able to accommodate two stereo channels, PCI or USB is required for five-channel surround sound. As discussed at IDF, the major concerns for PC OEMs and IHVs are choosing

the appropriate audio solution for their specific platform architectures, while cost-effectively managing the transition from the ISA bus to the new world of digital audio.

Graphics: Seeing is Believing

Much of the PC architectural discussions at IDF centered around **graphics** (<http://developer.intel.com/solutions/tech/aggp.htm>), which is one of the fastest growing and most dynamic segments of the PC platform. With the rise of **visual computing** (<http://developer.intel.com/solutions/archive/issue1/focus>)—both on the desktop and over the Web—graphics has now become the biggest differentiator among the various types of systems that make up the broad scope of PC system design. The growth from a 2D environment to a rich, textured 3D environment improves the user experience significantly.

The challenge for developers is to find ways to meet the widest possible customer requirements, while at the same time minimizing the variations in their product designs—an issue that raises questions of cost, development cycles and time to market. Along with a detailed list of hardware feature-set recommendations, PC 98 also defines a rich set of API interfaces (DirectX*) that will encourage scalable and consistent applications across the wide range of possible graphics hardware implementations.

While ISA removal, audio and graphics were major discussion topics at IDF, they merely represent the tip of the iceberg when considering the implementation of a balanced PC 98 system. For more detailed information on these and other platform enhancements, consult the **PC 98 System Design Guide** (<http://developer.intel.com/design/pc98/index.htm>)—one of the many ways that Intel is promoting innovation and helping to drive the adoption of open interfaces for the constantly evolving PC platform.

About the Author:

John Hyde is the lead platform architect and *PC 98 System Design Guide* editor for Intel. He served as the primary interface with Microsoft and the industry in developing and finalizing the guide.

For More Information:

For more information on PC 98, please visit the following resources:

Download or View on-line the **PC 98 System Design Guide** on Intel's Developer web site (<http://developer.intel.com/design/pc98/index.htm>).

For all the details on the PC 98 training track at the Intel Developer Forum, including all presentations given by Intel's top architects, please visit Intel's **PC 98 site** (<http://developer.intel.com/design/pc98/#IDF>).

To understand Intel's role in PC 98 development, read the **Leading the Way to PC 98** top story in *Platform Solutions* - Issue 1 by Jim Pappas, Director of Platform Technology (<http://developer.intel.com/solutions/archive/issue1/pc98>).

For a short overview of PC 98 and the latest news on the PC 98 initiative, stay tuned to the **PC 98 technology page** in *Platform Solutions* (<http://developer.intel.com/solutions/tech/pc98.htm>).

Introducing Intel Platform Performance Tools

Easing Technology Adoption and Improving Product Performance for PC OEMs and IHVs.

by Matt Gordon
Manager of IHV Ingredient Marketing
Intel Corporation

As PC technology continues to evolve and grow in complexity, PC OEMs and IHVs are finding it increasingly difficult to meet time-to-market schedules and the demanding expectations of their customers. One of the principal barriers historically confronting these vendors has been a general lack of performance tools designed to accelerate their hardware development efforts.

In response to these needs, Intel recently announced the availability of three platform performance and integration toolkits as part of its new Intel Performance Evaluation and Analysis Kit (IPEAK). Unveiled at the Intel Developer's Forum (IDF), the toolkits are designed to help PC OEMs and IHVs dramatically improve analysis and diagnostic capabilities in their platform integration and performance tuning efforts. As the first offerings of their kind in the industry, the IPEAK tools help shorten product time-to-market cycles when adopting new platform technologies and standards—such as AGP and industry power management initiatives, to name two examples. In addition, the tools provide automated testing solutions that reduce the time spent on testing during the system validation process.

The new Intel toolkits make it easier for OEMs and IHVs to understand performance issues and limitations that can be addressed in the design process to optimize product performance. For example, IHVs can use these tools to detect any performance pitfalls and make corrections while in the pre-production stage, thus lowering the risk of accruing additional costs and delays in the product shipment schedule.

Among PC products, higher price tags don't necessarily translate into better performance or reliability. The IPEAK tools enable system integrators and IT managers to evaluate and select the products that fit their customers' computing needs, while also keeping their spending within budget by empowering them with more complete knowledge of the performance matrix they need to use and understand.

IPEAK Tools: Paving the Way for Faster Development

The new IPEAK offerings include the IPEAK Power Management Analysis Toolkit, the IPEAK Storage Toolkit, and the IPEAK Graphics Toolkit. Here's a closer look at each of these solutions:

The IPEAK Power Management Analysis Toolkit (IPMAT) has been developed to help PC OEMs and IHVs incorporate the Advanced Configuration and Power Interface (ACPI) power management initiative in their product design and system integration processes. As the first tool developed for the kit, IPMAT simplifies the management of all ACPI and Instantly Available PC (<http://developer.intel.com/solutions/tech/power.htm>) platform ingredients by providing a mechanism to test for supported ACPI states at both the system and device level. It also enables OEMs and IHVs to qualify power management functionality, quantify power consumption and test the behavior of applications that incorporate Global System Power Management functionality.

The IPEAK Storage Toolkit has been developed to help vendors identify optimal storage performance at no cost or low cost in product designs, as well as to select the best possible performance storage products at the same price point. There are four tools in the kit: *RankDisk* provides the capabilities to compare relative device performance using relevant system-level workloads. *AnalyzeDisk* provides information on storage devices such as seek profile and caching algorithm efficiency. *Win32 Tracking Kit* is a tool for collecting system-level I/O traces for performance tuning. And the final member of the Storage Toolkit—*AnalyzeTrace*—complements the Win32 Tracing Kit by providing the capability to analyze system-level I/O traces.

The IPEAK Graphics Toolkit, which includes two toolkits, has been developed by Intel to provide OEMs and IHVs with different levels of analytical and evaluation capabilities for graphics. The

Graphics Performance Toolkit helps optimize performance by providing a better understanding of the performance issues and limitations related to graphics hardware and applications. And the *Intel Baseline AGP System Evaluation Suite* is a system integration and validation tool that provides the capability to test and evaluate **AGP** (<http://developer.intel.com/solutions/tech/agp.htm>) system-level functionality and utilization.

With the introduction of the IPEAK family of tools—which will be available in Q1 1998—Intel has become the first company to provide these specific kinds of platform performance and integration tools for PC OEMs, IHVs, system integrators, and IT managers. As such, the IPEAK tools represent our continuing efforts to share the results of our research and development activities with the industry—and by doing so, ease the development efforts of our worldwide customers.

About the Author:

Matt Gordon is Manager of IHV Ingredient Marketing in Intel's Desktop Products Group. Matt manages Intel's interface with IHVs and the industry to ease platform technology adoption.

For More Information:

For more information on Intel's IPEAK tools, please visit **the Platform Performance Tuning technology page** in *Platform Solutions* (<http://developer.intel.com/solutions/tech/ipeak.htm>) or visit Intel's new **IPEAK web site** (<http://developer.intel.com/design/ipeak>).

Implementing Wired for Management Throughout the Enterprise

Intel's Fall IDF and WfM Interoperability Workshop Showcase Enterprise Wide WfM Solutions

*By Chris Hughes
Director of Manageability Platform Marketing
Intel Corporation*

The integration of enterprise management applications and desktop environments is a "front-burner" issue with the corporate IT community. Now that leading PC OEMs are delivering Wired for Management (WfM)-enabled platforms, leading software suppliers are demonstrating that end-to-end WfM solutions can take advantage of instrumented desktops throughout the enterprise.

For the first time, enterprise applications can take full advantage of WfM capabilities, including instrumentation, remote new system set up, remote wakeup and power management from the desktop PC or server to the local management application (such as the Intel LANDesk[®] software). Now IT managers have the capability to enhance manageability functions including asset management, software distribution and diagnostics for troubleshooting in order to decrease the total cost of ownership.

Intel recently sponsored two events that focused on the hands-on implementation of end-to-end Wired for Management solutions for the enterprise. The first event provided developers with the tools and design guidelines needed for implementation of enterprise Wired for Management solutions. The other enabled over 20 leading hardware OEMs and software suppliers to demonstrate interoperability and evaluate the performance of end-to-end WfM implementations—both in test environments and against each other.

How-to Sessions at Fall IDF

At the Fall Intel Developer Forum, Intel shared tools and a detailed design guide that provided a step-by-step "how-to" program for the development of manageability solutions based on the WfM Baseline specification. Widely accepted WfM technology presented at IDF, such as DMI 2.0, provides OEMs with platform-independent interfaces that are extremely easy to implement. Intel provided access to its WfM experts for training on these tools and gave many demonstrations of WfM platform implementations.

Interoperability Workshop Showcases WfM Implementations

Intel also sponsored the WfM Baseline and **Network PC Interoperability Workshop** (<http://www.intel.com/pressroom/archive/releases/WM092997.htm>), where a large number of PC OEMs participated with key enterprise management solution providers to demonstrate the power of WfM implementations linked to Pentium[®] II processor-based desktop platforms.

In suites hosted by Intel, desktop PC and Net PC suppliers were given the opportunity to integrate their products in real-world environments with enterprise management solutions from leading suppliers. These included TME 10* from Tivoli Systems Inc., Unicenter* TNG* from Computer Associates International and HP OpenView* software from Hewlett-Packard Company."

Participants demonstrated end-to-end enterprise manageability capabilities in several areas:

- Remote new system set up, including centralized management of newly installed Net PCs beginning prior to the installation of the initial OS;
- Remote wakeup and power management from the centralized management application to the desktop PC;
- Platform-independent manageability to reduce the total cost of ownership in enterprise environments.

An Intel-supplied tool kit enabled the demonstration of a server software implementation of pre-boot services for Net PCs. The Intel Wired for Management Tool Kit, including the DMI 2.0 Service Provider SDK, were key factors in the rapid deployment of DMI-based manageability solutions.

The WfM Baseline specification and the Net PC specification are now actively supported by more than 20 leading PC OEMs. Intel's IDF and WfM Interoperability Workshops demonstrated that Wired for Management Baseline PC platforms and Net PCs are available now, and that software is now being implemented to provide interoperable enterprise manageability solutions.

Intel is providing the tools needed to quickly complete the development of hardware and software products which meet the demands of corporate IT managers for cost-effective enterprise manageability. Now is the time to take advantage of those tools to deliver products that support end-to-end Wired for Management solutions.

About the Author:

Chris Hughes is Director of Manageability Platform Marketing in Intel's Desktop Products Group. Chris is responsible for Intel's Wired for Management baseline specification and for enabling the industry to provide WfM baseline products.

For More Information: For more information on WfM and how to implement it in products now, please visit the following locations:

- Intel's **Wired for Management Tool Kit** site now including information and tools provided at the Fall IDF (<http://www.intel.com/ial/wfm>).
- The **Wired for Management Technology News page** in *Platform Solutions* (<http://developer.intel.com/solutions/tech/wfm.htm>).
- Intel's press announcement describing the **WfM Baseline and Network PC Interoperability Workshop** (<http://www.intel.com/pressroom/archive/releases/WM092997.htm>).
- See Intel's **Managed PC web site** for information on managing the computing environment for IT professionals (www.intel.com/managedpc/).

Focus:

Moore's Law: Changing the PC Platform for Another 20 Years

Intel already had a robust track record with microprocessor development when IBM* chose the 8088 processor as the heart of the 1981 IBM PC. The 8088 was a 16-bit, third-generation microprocessor that followed "Moore's Law" as shown in the left of Figure 1. Gordon Moore made his first observation about the "doubling of transistor density on a manufactured die every year" in 1965, just six years after he invented the planar transistor and four years after he and Bob Noyce produced the first planar integrated circuit. Gordon admits that, initially, he did not expect his law to still be true some 30 years later, but he is now confident that it will be true for another 20 years as shown in Figure 1.

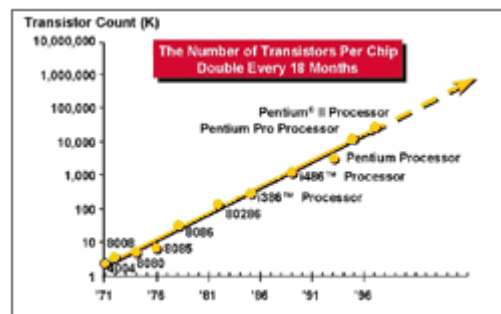


Figure 1

Economic Challenges

The economic result of Intel's relentless pursuit of Moore's Law is actually more remarkable. The average price of a transistor has fallen by **six orders of magnitude** due to microprocessor development. This is unprecedented in world history; no other manufactured item has decreased in cost so far, so fast. It is interesting, therefore, to look into this silicon technology to understand its scope and to be able to predict its future.

Intel's microprocessors, and many other integrated circuits, are manufactured using a planar process where a pure silicon wafer is selectively masked and diffused with chemicals to make multiple transistors. This combination is then selectively masked again and metal is deposited on the wafer to interconnect these transistors. The first integrated circuit used only one layer of metal; today's Pentium® II processor uses five layers of metal to increase the packing density as shown in Figure 2.

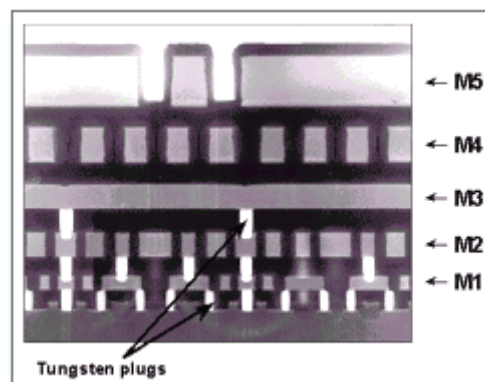


Figure 2

Transistor density is the key price driver of integrated circuits. The area on a wafer is a fixed cost (about \$1B/acre) so product complexity and price will depend upon how small the transistors can be made.

Making transistors smaller is “all benefits”: smaller transistors operate faster, interconnections are smaller, system reliability is increased since more functions are integrated into a single place, the power is lower and the cost is cheaper. Everything gets better and there are no real engineering tradeoffs to make. The results that Intel has achieved in its microprocessor development are shown in Figure 3. Notice how the die from each processor gets progressively smaller with each new silicon process and notice how the next generation processor is then larger with more transistors on it. The cycle then repeats: smaller, faster, and cheaper. The market demand for higher performance Intel processors is growing exponentially, so making them smaller also allows us to meet customer demand.

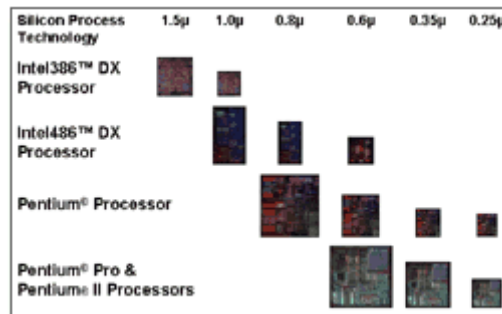


Figure 3

Intel's challenge in making transistors smaller consumes a large R&D budget and results in new factories being built and retooled for each new generation of microprocessor. The manufacture of processors in large volumes is a capital-intensive business which now costs over \$3B/year. There have been dramatic changes in manufacturing to meet today's demand. In the 1970s the technicians wore smocks and used tweezers to move the wafers from one process step to the next. A fab plant today is quite different: The technicians wear self-contained bunny suits (the real ones are white, they turn shades of metallic when put close to a marketing person!) and they work in an extremely clean environment (over 100 times cleaner than the best operating theater) with robots moving large numbers of wafers between the multiple processing steps.

Atomic Challenges

So where do we go from here, and what are the challenges looking forward? Today we have the ability to integrate a doubling transistor count every 18-24 months. The challenge is deciding what to integrate, how to manage the increased complexity and how to validate the design. We must also consider interconnection delays, increasing power dissipation due to the large transistor count, and the shorter wavelengths of light used in the photolithography process due to the smallness of the devices. All of these challenges are solvable with money and effort. One challenge, however, that will be difficult for even Intel to solve, is the fact that when transistors get smaller the gate thickness starts to approach the atomic nature of matter! It is postulated that the thinnest gate cannot be less than ten atoms thick and at our current rate we should reach this by the year 2017. Not a major concern today, but something that Intel has a research team working on.

What to Integrate

There are many computer architecture techniques that can be employed inside the processor core to increase its performance. Fundamental techniques such as cache memory and a floating point unit were added to the processor core early on. Advanced techniques such as pipelining and multiple instruction execution were added with the Pentium® processor. Leading-edge architectural techniques such as speculative execution and data-readiness, run-time instruction scheduling were added with the Pentium Pro processor. Computer science is now looking forward with a changed paradigm: Don't be constrained by the hardware implications of an approach; we'll have the technology within a short time to implement it.

Transistors within the processor core communicate with each other at extremely high speed—the Pentium II processor is at 300MHz today and this core frequency will continue to increase in 1998. When communicating with transistors on other devices the signaling must go via the relatively slow component-to-component interconnect. This has the potential of reducing system performance. A simple solution is to

integrate more of the system hardware functions into the processor core. This must be traded off with the cost effectiveness of implementing the system function in software or in dedicated hardware or a combination of the two. This hardware/software balance will be continually optimized as we move into higher performance, future processor generations.

Managing Complexity

The increase in transistor density has caused a similar increase in engineering staff. There are now many hundreds of architects and design engineers working at numerous Intel sites all over the world on next-generation processor implementations. The project management challenges to keep such a large team focused and productive requires a sophisticated computer network with advanced workstations and development tools. It is interesting to note that only the very latest generation of Pentium II processor based machines has enough horsepower to be used in creating the next generation processor! And so the cycle continues.

Design Validation

Design validation and verification is now an integrated part of the design process; in the early days, it was done after the processor was designed. Intel has approximately the same number of engineers testing and validating its processor designs as those architecting and designing. Additional circuitry is added to the processor core to ease the debug and validation process. Test coverage models are generated so that each and every logical function can be thoroughly tested. Additionally, legacy software tests are run on the computer model to ensure software compatibility with previous processor generations.

Interconnection Delays

As the geometries of a transistor get smaller, the propagation delays through the device also get smaller. Unfortunately, as the metalized interconnects get smaller, their resistance and capacitance increases and therefore the propagation delay through them increases. As we move to 0.25micron geometries the delay through the metal is more than the delay through the transistor—not at all what we learned in engineering school! Intel has multiple approaches to this challenge—the most obvious being to use a metal with a higher conductivity than the aluminum currently used in production. Copper offers some attractive solutions but this is more difficult to process. Alternative design techniques that use more transistors and less interconnects are also being investigated.

Power Dissipation

As the transistor count goes up then so does the power dissipation. More important, however, is the corresponding increase in frequency, since power increases as the *square* of the frequency. The only variable that is changeable in the power equation is supply voltage—power dissipation is also proportional to the square of the voltage. So we must reduce voltage as we move forward into the future. The “same-power” voltage for an 0.18micron process is 0.5 volt, compared with 3.3 volts today. But operating at 0.5 volt will present new challenges, since a few millivolts of supply variation or noise across the processor core will now be a significant percentage of transistor switching voltage.

Lithography Limits

Today's 0.35micron process uses visible light in its production lithographic process. Intel's 0.25micron process has moved to deep ultraviolet. Research into the 0.18micron process is pushing deeper into the ultraviolet spectrum: the benefits of 193nm light is that the same optical tools and process methods can be used. Good experimental results have been obtained in the lab but tools do not currently exist for large area coverage or for a production environment. Looking forward to 0.13micron, Intel is researching extreme ultraviolet, x-rays and direct-write electron-beam techniques.

Micro 2012

There are no theoretical or practical challenges that will prevent Moore's Law being true for another 20 years at least—this is another five generations of processors. Using Moore's Law to predict into 2012 Intel should have the ability to integrate 1 billion transistors on to a production die that will be operating at 10GHz. This could result in a performance of 100,000 MIPS. This is the same increase over the Pentium® II processor as the Pentium II processor was to the 386! This prediction is so staggering that it borders on unbelievable—but our increased investment in silicon R&D has continued to produce these kinds of results. Intel sees no fundamental barriers in its path to Micro 2012, and the theoretical physical limitations of wafer fabrication technology won't be reached until the year 2017.

Impact on the PC Platform

For the first time since the original PC, we have processor performance being applied outside the primary needs of software applications. Some applications will continue to drive for maximum available performance but others will use the processor capabilities in other ways. Mobile systems are able to slow the processor down to conserve battery life and still deliver incredible performance to the user. PCs targeted at home entertainment could use the processor performance to decompress an MPEG-2 video stream in software. This reduces the cost of the PC by removing specialist decompression hardware making the system more affordable to a larger audience. The operating system can also take advantage of this increased processor performance by doing system integrity work such as virus detection, software upgrades, file consolidation and systems management as *background tasks*. The delivered processor performance is allowing the PC platform to evolve out of its "one-size-fits-all" paradigm into purpose-built systems which match customer requirements as shown in Figure 4. These systems are all based upon the same processor core so they all run the same operating system and support the same applications. Each system is tuned on top of this baseline capability to deliver features targeted at its respective audience. Applications are designed to be scalable across multiple platforms, and a "high-end" system will typically deliver a better user experience.



Figure 4

New PC Platform Usage Models

An area which has taken full advantage of the increasing silicon technology is graphics. It is now possible to get amazing 2D and eye-popping 3D graphics at volume desktop price points. This is a natural evolution of the desktop platform, and the term "Visual Computing" has been coined to describe this recent phenomenon (see last month's *Platform Solutions* Focus section on Visual Computing—(<http://developer.intel.com/solutions/archive/issue1/focus.htm>)). It is now just as easy to create a full-color video clip with sounds as it used to be to create a graphic layout—and if you are trying to sell a vacation in Hawaii, then it is much more compelling to use a video with waves softly crashing in the background than to use a static graphic. The Internet is changing how people interact. When combined with visual computing capabilities, businesses and consumers will have the ability to interact "screen-to-screen," no matter where they are located.

Lower Cost Peripherals

Another area that processor performance is used to great effect is the lowering cost of attached peripherals. The modern peripheral is essentially a “sensor-on-a-wire,” and any required signal processing is done by the host processor. A digital camera, for example, captures its picture on a CCD sensor and passes this raw data via a **Universal Serial Bus** (USB) <http://developer.intel.com/solutions/tech/usb> cable into the PC platform; the host processor implements color space conversion, aspect ratio correction, scaling and interpolation, gamma correction and white balance. The software could also correct for dead-pixels in the sensor and will manage user preferences. The same technique is being employed on scanners, photo-printers, plotters and a variety of new gaming peripherals. This reduces the cost of the platform by removing specialist hardware and thus makes the system more affordable to a greater market.

Summary

The silicon technology inside the PC platform continues to evolve and deliver twice the processor capability every 18–24 months. The electronics around the processor is also evolving so that these increased capabilities can be used by the basic PC platform. The PC platform itself is diversifying into multiple usage models and application areas, all driven by customer demand. This all adds up to a better user experience, all made possible by Intel continuing to prove Moore's Law to be true.

Platforms:

Business Platforms

What's New:

- Intel Shows Paths to **Competitive Business Computing at Networld+Interop**
(<http://www.intel.com/pressroom/archive/releases/nw100797.HTM>)
- **PC Industry Delivers on Manageability**—Wired for Management and Net PC Interoperability event shows momentum of WfM
(<http://www.intel.com/pressroom/archive/releases/WM092997.HTM>)
- Compaq* and Hewlett-Packard* unveiled **new systems based on Intel's WfM specification**
(<http://www.techweb.com/crn/dailies/weekending100397/sept29digJ.html>)
- Intel updates **Wired for Management ToolKit** with latest WfM Building Blocks including a New WfM Design Guide to help Developers implement WfM Capabilities
(<http://developer.intel.com/ial/wfm/>)
- Intel Architecture Puts **Java* to Work**
(<http://www.intel.com/businesscomputing/archive/tech3.htm>)

Overview:

The proliferation of hardware and software choices, and the explosion of the Internet and intranet have made the business computing environment increasingly complex and expensive to deploy and manage. Intel is continuing to bring greater performance and capability to the standard business desktop PC, while at the same time increasing its efforts to make it easier to deploy and control.

With the introduction of the Pentium® II processor Intel has combined the power and capabilities of the Pentium® Pro processor with the multimedia and communications capabilities of MMX™ technology. Along with platform technologies like Accelerated Graphics Port (AGP), the standard business desktop now has the **visual computing** (<http://developer.intel.com/solutions/archive/issue1/focus.htm>) capabilities of PC imaging, 3D graphics, and enhanced video processing that will take business computing to the next level and change the way businesses work with each other and with consumers.

Intel is now working with the industry on technologies that reduce the total cost of ownership and make PC's inherently easier to manage. The Wired for Management (WfM) initiative and Network PC (Net PC) platform are two examples of the tremendous progress made to enable greater control and lower Total Cost of Ownership (TCO).

Wired For Management:

Intel's Wired for Management (WfM) initiative is part of a broad-based industry effort to reduce the costs of business computing without compromising compatibility or performance. The initiative includes new hardware and software products to help OEMs and others implement WfM capabilities, alliances with other industry leaders, education and development programs, and Intel-led industry efforts aimed at developing widely accepted manageability standards. Most importantly, the WfM initiative targets real reductions in the most expensive element of business computing: support.

The WfM Baseline Specification establishes a minimum set of management interfaces that enable such capabilities as remote configuration and installation of operating systems and software applications, remote system inventory and monitoring, and after-hours maintenance. OEMs can build further capabilities on this baseline to deliver even more value to their customers

Network PC (Net PC):

The Network PC, or Net PC, was born out of Intel's WfM initiative to reduce TCO without sacrificing necessary performance. The Net PC introduces a new category of business PC designed from the ground-up to be centrally managed, while simultaneously delivering the power and versatility of a traditional business desktop computer. The benefits of the Net PC include remote system configuration over the network, automated distribution of software, simplified remote diagnosis and maintenance, asset management support and a sealed chassis. The built-in manageability features and locked chassis of the Net PC give IT (Information Technology) support staff a known entity, while at the same time locking systems to reduce unauthorized or unplanned changes in the client.

Wired for Management Technology**What's New:**

- Wired for Management Interoperability event shows momentum of WfM building blocks (www.intel.com/pressroom/archive/releases/WM092997.HTM)
- Intel delivers detailed WfM implementation training and tools at the Intel Developer Forum (<http://developer.intel.com/ial/dmi/class/index.htm>)
- Compaq* and Hewlett-Packard* unveiled new systems based on Intel's WfM specification (<http://www.techweb.com/crn/dailies/weekending100397/sept29digJ.html>)
- Intel updates Wired for Management ToolKit with latest WfM Building Blocks: (<http://developer.intel.com/ial/wfm/>)
 - * Wired for Management Design Guide
 - * Intel DMI 2.0 Service Provider SDK
 - * Managed Object ToolKit
 - * Intel Mobile Component Instrumentation SDK version 1.0
 - * Intel DMI SDK for Servers
- Wired for Management Baseline Specification Version 1.1a released (<http://www.intel.com/managedpc/spec.htm>)
 - * Now Includes Mobile and Server
- System Management BIOS specification version 2.1 now available (<http://www.intel.com/managedpc/standard/smbios.htm>)
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

"Manageability" is a **BIG** subject and the focus of several industry-wide initiatives. Intel's Wired for Management (WfM) initiative seeks to raise the level of management capabilities for mobile, desktop, and server platforms. The complementary Zero Administration for Windows* initiative from Microsoft* seeks to create more manageable operating systems and applications. The collective goal of these initiatives is to help plan, deploy, proactively maintain, and centrally control a distributed computing environment, in order to reduce the overall cost of owning and managing computers in the enterprise.

The WfM Baseline describes a consistent set of management capabilities which defines the minimum functions delivered in a target platform. These include requirements for instrumentation, remote wake-up, power management and service boot capability. Along with the WfM Baseline specification, Intel has produced a set of development tools designed to ease deployment of these capabilities. These include the Intel DMI 2.0 Service Provider SDK, the Managed Objects Toolkit for rapidly developing management applications, the Mobile Component Instrumentation SDK for laptops, and the DMI SDK for Servers. Intel has also made available a WfM Design Guide showing the "how-to" details on implementing the WfM capabilities.

Benefits to Users:

The benefits of WfM baseline-compliant systems are clear. It enables centralized system management: inventory, fix/repair, configuration and diagnostics, and provides for off-hours maintenance to minimize downtime. Picture a user who's having a problem with a built-in fax program and calls the company support hotline. The user continues using the system while a support technician remotely views the user's configuration and discovers that some files are mismatched to the hardware. The technician makes the needed changes and updates the correct files, all in the background, while the user continues working. Another common scenario is where the IT administrator updates to the latest version of the office productivity application suite automatically during the middle of the night without any user intervention.

Benefits to Manufacturers:

The WfM Baseline is easy for OEMs and developers to adopt and deploy and is based on industry standard management technology. DMI 2.0, for example, is a non-proprietary interface that is easy for vendors to adopt. In addition, DMI is independent of any specific operating system, hardware platform or management protocol. The interface is scaleable to accommodate a wide range of products and mappable to existing management and remoting protocols.

Intel's Wired for Management ToolKit makes it easy for OEMs, IHVs, and ISVs to adopt and deliver management capabilities. The tools encourage the addition of value added features on top of the WfM Baseline within its open-specification structure. The Baseline also provides a consistent target for applications developers including enterprise wide management solutions.

Industry Status:

Since its initial release in April 1997, the WfM Baseline specification and its companion, the Network PC (Net PC) specification, have received wide industry support from a variety of key industry players. For more information on **supporting companies** see:

<http://www.intel.com/pressroom/archive/releases/nw31297b.HTM>

For **Mobile**, visit <http://www.intel.com/pressroom/archive/releases/NW060297.HTM>,

For **Server** visit <http://www.intel.com/pressroom/archive/releases/wm063097.htm>

Evidence of the widespread momentum for the WfM initiative was recently demonstrated at the second Intel WfM interoperability workshop on September 26, 1997. Over 20 industry leaders tested the interoperability of manageable platforms and management software showing that Manageable PCs and Net PCs are here now and so are the tools to manage them (see the **press release** describing the event at <http://www.intel.com/pressroom/archive/releases/WM092997.HTM>).

Intel also provided detailed technical training and tools to further assist OEMs and IHVs in implementing the WfM Baseline specification at the Intel Developer Forum held on September 29, 1997. For more information on the **IDF WfM track** please go to (<http://developer.intel.com/ial/dmi/class/index.htm>).

Intel and Microsoft are working closely to align their management technologies. This is evident in the work that produced the Network PC (Net PC) specification, which was co-authored by Intel and Microsoft along with other industry partners. The two are continuing to assure that next generation Windows* operating systems are compatible with today's management technologies. This includes joint work on the *PC 98 System Design Guideline* just released in September 1997, and the *Windows Hardware Instrumentation Implementation Guide* (WHIIG) expected to be available in late 1997 or early 1998.

Next Steps:

Specifications have been available on both the WfM baseline and the Net PC since early 1997. Tools and training have been delivered to the industry. Two interoperability events have been held showing the momentum behind the WfM baseline and the arrival of product building blocks. If you are currently designing systems or products for desktop PCs, mobile PCs, or servers, now is the time to design and deliver WfM-based products so that businesses can take advantage of this technology to reduce total cost of ownership.

If you missed the **Intel Developers Forum** (9/29/97–10/1/97), check out all the presentations on-line at: (<http://developer.intel.com/ial/dmi/class/index.htm>) for more details.

For More Information:

For more information on Mobile manageability, please visit the **Mobile PC Manageability site** (<http://www.intel.com/mobile/entrprse/managePC/index.htm>).

Helpful development tools may be downloaded from the **Wired for Management ToolKit** site for immediate deployment (<http://developer.intel.com/ial/wfm/>).

For more information on the **Network PC (NetPC)** visit Intel's Net PC web site at (<http://www.intel.com/businesscomputing/netpc/>).

For information on Intel's building blocks and **management products** visit (<http://www.intel.com/managedpc/product.htm>).

For more information on **DMI and the DMTF** visit the industry DMTF web site at (<http://www.dmtf.org>).

Intel's **ManagedPC** web site contains information on WfM targeted at IT professionals (<http://www.intel.com/managedpc/index.htm>).

For information on Microsoft's **Zero Administration for Windows (ZAW)** initiative visit their web site at (<http://www.microsoft.com/windows/zaw/>).

Network PC (Net PC) Technology**What's New:**

- Wired for Management Specification 1.1a Available
(<http://www.intel.com/managedpc/spec.htm>)
- Intel Developer's Forum—Wired for Management Track held on 9/29/97
(<http://developer.intel.com/ial/dmi/class/index.htm>)
- Second WfM Baseline and Net PC Interoperability Test Event Held 9/26/97
(<http://www.intel.com/pressroom/archive/releases/WM092997.HTM>)
- Compaq* First to Ship Net PC Solutions
(<http://www.compaq.com/newsroom/pr/pr220997a.html>)
- Net PCs Introduced by Intel and the Industry—June 97
(<http://www.intel.com/pressroom/archive/releases/wm061697.htm>)
- Network PC (Net PC) System Design Guidelines
(<http://www.intel.com/managedpc/standard/netpc.htm>)

- Net PC Case Studies
(<http://www.intel.com/businesscomputing/netpc/>)
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

The Network PC, or Net PC, is a new category of business PC intended to reduce ownership costs through its advanced management capabilities while delivering the power and versatility of traditional business PCs. Advanced system administration features, including remote configuration and repair and the ability to “wake up” systems for off-hours maintenance, give IT organizations greater centralized management capabilities while retaining existing LAN infrastructures. Hard disk drives give users the choice of running their Windows*-based business software and storing data locally or on servers.

The Network PC System Design Guidelines specify a number of advanced manageability features that enable easy, central administration. These include:

- **Remote boot.** The system can boot from a management server to receive downloads or updated operating system software or applications.
- **Remote wake-up (Wake-On-LAN* technology).** The system can be turned on remotely for after-hours maintenance.
- **DMI 2.0 support.** System elements using the Desktop Management Interface can be recognized and managed by industry-standard management software.
- **Instrumentation.** System elements such as the baseboard, processor, disks, mouse, keyboard, BIOS and video card can identify themselves and provide management information to standards-based management software.
- **SMART hard drive.** The disk can indicate when it may be about to fail, giving the user time to avoid data loss.
- **Hardware monitor.** The system tracks various indicators of hardware health, such as temperature or chassis open.

Net PCs are “managed” business PCs that cover the full range of price/performance, including high-power systems based on Intel's Pentium® II processor. Products based on the guidelines are emerging at a wide range of performance levels and price points. The Net PC System Design Guidelines was developed by Intel, Microsoft*, Compaq*, Dell* and Hewlett-Packard*.

Benefits to Users:

With its advanced management technologies, controlled configurations and sealed case, the Net PC gives IT managers increased control over the distributed computing environment. In addition, The Net PC offers a platform that is cost-effective to deploy, manage and support, without sacrificing the desktop computing power, local storage and application flexibility that make the PC a versatile and powerful tool for users. By combining PC versatility and performance with centralized, network-based manageability, the Net PC truly delivers a valuable new tool for business. The Net PC is most appropriate for companies centralizing PC management and for those data- and task-focused users who need no hardware expandability. For example, it is ideal for information delivery, customer support, manufacturing, finance and training.

Benefits to Manufacturers:

The overall Net PC solution is spurring the adoption of manageability by driving initiatives to increase base client management capability. By designing to the Net PC System Design Guidelines OEMs will be able to integrate network-based remote manageability features into their business desktop PC product lines.

Industry Status:

Intel's announcement of the Wired for Management (WfM) initiative in September 1996 generated considerable enthusiasm for managed PCs from OEMs, independent workgroup and enterprise management software vendors, and end-users. Intel has followed up the initial announcement with a series of events and tools delivered to the industry in 1997. The following events have taken place this year to further enable manageability in PCs and servers:

- *Publication of the Wired for Management Baseline 1.0*
- *Publication of the Net PC System Design Guidelines*
- *Net PC Interoperability events (June and September)*
- *Net PC Introduction and Product Announcements*
- *Publication of the Wired for Management Baseline 1.1a*
- *Publication of the Wired for Management tool kit*

The second WfM Baseline and Net PC Interoperability test was held on September 26, 1997. Over 20 OEMs, IHVs, and Manageability vendors attended and tested their products showing that Manageable PCs and Net PCs are here now and so are the tools to manage them, (see the **press release** describing the event at <http://www.intel.com/pressroom/archive/releases/WM092997.HTM>).

Intel also provided detailed technical training and tools to further assist OEMs and IHVs in implementing the WfM Baseline specification at the Intel Developer Forum held on September 29, 1997. For more information on the **IDF WfM track** please go to (<http://developer.intel.com/ial/dmi/class/index.htm>).

Net PCs are beginning to ship in the third quarter of 1997.

Next Steps:

Specifications have been available on both the WfM baseline and the Net PC since early 1997. Tools and training have been delivered to the industry. Two interoperability events have been held showing the momentum behind WfM baseline and Net PC and the arrival of product building blocks. Now is the time for OEMs, IHVs, and Manageability software vendors to design and deliver WfM-based and Net PC products so that businesses can take advantage of this technology to reduce total cost of ownership.

For More Information:

For more details on Net PCs, visit **Intel's Net PC web site** at (<http://www.intel.com/businesscomputing/netpc/>).

For more details on the Wired for Management initiative from an IT perspective, visit **Intel's Managed PC web site** at (<http://www.intel.com/managedpc/index.htm>).

For all the instructions, tools, and specifications for delivering Wired for Management systems and products, visit the **WfM Toolkit site** at (<http://developer.intel.com/ial/wfm/>).

Platforms: (continued)

Home Platforms

What's New

- Intel Introduces **Create & Share™ Camera Pack**
(<http://www.intel.com/pressroom/archive/releases/PS091597.HTM>)
- **Details** on the Create and Share Camera Pack
(<http://www.intel.com/createshare/looktech.htm>)
- Intel's Pentium® II Processor Hits the Web
Comprehensive **Consumer Marketing & Advertising Campaign** Kicks Off
(<http://www.intel.com/pressroom/archive/releases/CN091697.HTM>)
- **Pentium® II processor-based systems available** in retail from major PC manufacturers
(<http://www.intel.com/PentiumII/systems/index.htm>)

Overview

The Home PC is already the center of creativity, entertainment and education in many households today. With the advent of the Pentium® II processor and Dual Independent Bus (DIB) architecture, and new platform technologies such as AGP, USB and DVD, the home PC is bringing new compelling capabilities to both experienced consumers and first-time buyers. The introduction of Intel's Pentium II processor, when combined with the Internet and the emergence of PC photo processing, video editing, 3D graphics, digital audio, and video phones is changing the way we work, learn, play, and communicate using our PCs at home.

Advancing the processor and platform technologies is critical to driving new levels of performance and capability that enable new and exciting PC platform uses. These new platform technologies go hand in hand with the enhanced capabilities of the Pentium II processor. Now available at speeds of 233-, 266-, and 300-MHz, the Pentium II processor combines the advanced features of Intel's sixth-generation processor, like Dynamic Execution and Dual Independent Bus architecture, with the enhanced multimedia and communications processing power of MMX™ technology.

The Pentium II processor delivers the best performance on all three vectors of computing: integer execution, delivering higher performance on all consumer software; floating point, delivering improved 3D graphics for more realistic images and games; and multimedia, using MMX technology to deliver improved imaging, video, and communications. When combined with Intel's newest AGP chipset, arcade quality graphics and DVD are possible now on the mainstream consumer PC.

Educated consumers are demanding the best PC performance to be ready for new and exciting applications. Multipurpose PCs are evolving into special categories focused to meet the needs of these educated consumers. Two major trends have emerged in consumer PC usage today: creativity and entertainment. Intel is enabling platform improvements that support these trends through the Creativity PC and the Entertaining PC initiatives.

Creativity PC

The **Creativity PC** (<http://developer.intel.com/solutions/tech/creapc.htm>) enables enhanced multimedia and imaging capabilities to make possible:

- Personal photography and albums
- Audio mixing and remixing
- Video editing
- Communicating your creations with family and friends

The emergence of low-cost digital cameras with USB connectivity is making the Creativity PC a hot new category this year. These cameras utilize the PC processing power of the Pentium II processor with MMX technology to allow you to capture, store, edit, and send digital photos over the Internet.

Entertaining PC

The Entertaining PC takes the traditional consumer desktop multimedia PC to a new level of capability using the Pentium® II processor, DIB architecture, AGP, DVD, and AC '97 Audio. Consumers who enjoy games and edutainment will now be able to experience a dramatic new level of 3D realism. With the inclusion of DVD drives, the Entertaining PC allows the user to play back high-quality DVD movies and take advantage of rich interactive DVD applications. With DVD, ISVs are taking advantage of the increased storage capacity to provide higher quality video, audio and graphics in games, edutainment and reference applications. Please see the following pages in Platform Solutions to learn how Intel is enabling these critical Entertaining PC platform technologies.

- **AGP** (<http://developer.intel.com/solutions/tech/agp.htm>)
- **DVD** (<http://developer.intel.com/solutions/tech/dvd.htm>)
- **Audio** (<http://developer.intel.com/solutions/tech/audio.htm>)

Creativity PC Technology

What's New:

- Intel Introduces **Create & Share™ Camera Pack**
(<http://www.intel.com/pressroom/archive/releases/PS091597.HTM>)
- **Details** on the Create and Share Camera Pack
(<http://www.intel.com/createshare/looktech.htm>)
- **Pentium® II processor-based systems available** in retail from major PC manufacturers
(<http://www.intel.com/PentiumII/systems/index.htm>)
- Lots of information available on the **benefits of the Pentium II processor** for the Home platform.
(<http://www.intel.com/home/PentiumII/index.htm>)
- **Portable PC Camera '98** Design Guideline available now!
(<http://www.intel.com/imaging/trends/guidelin.htm>)
- Intel's new **PC Imaging Site**
Lots of new information including links to Intel's Smart Video Recorder III and Kodak's FlashPix* file format site (<http://www.intel.com/imaging/index.htm>)
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

The Pentium II processor, when combined with cool creativity software, enables new capabilities in:

- Video editing and playback (splice 'n dice your own videos)
- Audio remixing (Mix your own sound tracks)
- PC Imaging (capture, edit images, store and share with friends)

Imaging software has exploded with many popular titles designed for Intel MMX™ technology which brings significant performance to the category. Today digital cameras, scanners and photo printers are widely available at affordable prices. Audio creativity has hit mainstream. Previously audio was only available to musicians with special input devices and complicated software. Now with consumer software and the power of the Pentium II processor, anybody can be a musician.

Some of the features expected on the 1H'98 Pentium II processor-based Creativity PC SKUs are: video capture; audio and video in/out connectors; USB connectors; CD-recordable/Zip drive; PCI audio (AC'97); POTs video conferencing camera; software for video, image, and music editing.

PC OEMs also have the opportunity to include imaging peripherals like scanners, photo printers, and digital cameras.

Other technologies developing on the consumer platform to support Creativity PCs either now or in the future are:

- **USB**—(<http://developer.intel.com/solutions/tech/usb.htm>)
- **1394**—(<http://developer.intel.com/solutions/tech/1394.htm>)
- **AGP**—(<http://developer.intel.com/solutions/tech/agp.htm>)
- **DVD**—(<http://developer.intel.com/solutions/tech/dvd.htm>)
- **Digital Audio**—(<http://developer.intel.com/solutions/tech/audio.htm>)

Benefits to Users:

The Pentium II processor-based PC is the center of Creativity. It is unparalleled in handling pictures and video on your PC. New uses for consumers include photo management and albums, photo editing, personal publishing, Internet post cards, video editing, music creation, and 3D for fun. Here are some examples of what consumers can do with their creativity PC's:

- Entertainment: digital "shoebox," personalized cards, family tree, games, hobbies, home movies
- Utility: book reports, asset inventory, home improvements
- Sharing: E-mail, WWW, prints
- Video/image management: archival, retrieval
- Image manipulation: enhancement, orientation, size
- Video editing: add text, special effects, transitions
- Small business: presentations, sales collateral, product catalogs, brochures, newsletters, publishing

The PC just got more exciting with the Creativity PC!

Benefits to Manufacturers:

New opportunities to sell new PCs and peripherals. Consumers are looking to buy digital cameras and PCs that have creativity capabilities.

Industry Status:

Creativity PCs are available now! PC OEMs are quickly recognizing the purchasing power of this prospective audience. New creativity PCs are available now from major manufacturers. More are expected in 1998 as the Pentium II processor moves into the volume mainstream.

Next Steps:

Offer Pentium II processor-based Creativity PC SKUs in 1H'98 with video editing software, video capture, CD-recordable storage, audio and video in/out. Look for opportunities to sell peripherals and software as

part of your Creativity PC SKU. Other opportunities include providing incentives for end-user purchase of peripherals and software.

Take advantage of Intel's Pentium II processor advertising campaign and promote the Creativity PC in the channel and in your advertising to increase awareness for the category.

For More Information:

Lots of information available on the usage of Intel's **Pentium II processor for the Home**

(<http://www.intel.com/home/PentiumII/index.htm>).

Visit Intel's **Create & Share(TM) Camera Pack web site** and learn how the camera and the PC can be used for fun (<http://www.intel.com/createshare/crshare.htm>).

Intel's new **PC Imaging site** with lots of new information including links to Intel's Smart Video Recorder III and Kodak's FlashPix* file format site (<http://www.intel.com/imaging/index.htm>).

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- **AGP**— (<http://developer.intel.com/solutions/tech/agp.htm>)
- **DVD**— (<http://developer.intel.com/solutions/tech/dvd.htm>)
- **Digital Audio**—(<http://developer.intel.com/solutions/tech/audio.htm>)

Platforms: (continued)

Mobile Platforms

What's New

- New **Mobile Pentium® Processors with MMX™ Technology** Provide 40% Increase in Performance and 50% Lower Power Consumption (<http://developer.intel.com/design/mobile/>)
- Intel Hosts **Industry Symposium** to Deliver High-Performance, Power-Efficient Mobile PCs (<http://www.intel.com/pressroom/archive/releases/MP091797.HTM>)
- **Mobile Power Initiative & Mobile Power Guidelines 99** Introduced by Intel (<http://developer.intel.com/design/mobile/intelpower/>)

Overview

Providing Mobile PC users with the flexible environment they require has always been a challenge. IT management challenges include affordability, maintenance, administration, productivity and security. Notebook users need desktop equivalent capabilities in a mobile form factor that's portable. They won't sacrifice performance for mobility, and they need the lowest possible power consumption providing the longest battery life on the road. Users also require seamless communications—over the LAN, the phone line, and through wireless technologies.

Intel is meeting those challenges with its mobile computing vision: anytime, anywhere performance and productivity. Intel is committed to enabling and delivering cost effective, high performance computing solutions that focus on power efficiency, remote manageability, and mobile communications.

Mobile Power Initiative

Intel recently doubled the performance per watt with the introduction of the new mobile Pentium® processor with MMX™ technology at 233MHz. However, as the industry prepares to design systems for 1999—and users continue to demand more features—balancing power, battery life and size is ever more challenging. By designing with the Mobile Power Initiative in mind, it is possible to deliver high-end mobile features without sacrificing reliability and extended battery life.

The Mobile Power Initiative is an industry-wide program for mobile PC system manufacturers, component suppliers and software vendors. This comprehensive initiative addresses the industry's power consumption challenges in three major areas: System Hardware, System Software, and Application Software. Intel has made available new high-performance, power efficient microprocessors and other building blocks, new Mobile Power Guidelines (revision 0.80), and a broad array of tools and specifications to support power efficient hardware and software development.

The initiative is supported by a broad array of leading PC system manufacturers, component suppliers and software vendors including IBM*, Toshiba*, Compaq*, Dell* and NEC*, among others. For more information on Intel's Mobile Power Initiative, or to provide input to the Mobile Power Guidelines prior to revision 1.0, please visit Intel's new **Mobile Power Initiative** developer web site (<http://developer.intel.com/design/mobile/intelpower/>).

Mobile Manageability

Through the **Wired for Management initiative** (<http://developer.intel.com/solutions/tech/wfm>), Intel is leading the industry to define and deliver the managed mobile PC. Remote manageability was recently added to the WfM Baseline specification, and Intel is providing mobile instrumentation tools and software to enable mobile OEMs to offer managed mobile PCs.

The TCO for notebook computers is higher than for desktops, largely due to IT support costs.

Mobile computers are only occasionally connected; they have a smaller 'pipe' connection, and they tend to use a variety of dynamically swappable devices. But administrators still need all of the desktop management features, such as software distribution, asset tracking, and remote diagnosis/repair, plus additional features to address unique mobile challenges. Intel's WfM initiative is now beginning to address these for mobile computers.

By offering mobile manageability solutions—such as tools to enable platform instrumentation, as well as the LANDesk Client Manager application—we are able to lower the total cost of ownership by providing mobile clients and administrators with reduced downtime and higher productivity than ever before.

Several leading manufacturers are already shipping early versions of mobile managed PCs today. These systems provide desktop equivalence while connected to the LAN. Intel will help OEMs to enable more fully instrumented notebook platforms and remote dial-up by the first half of 1998.

Mobile Data Initiative

Formed and led by Intel, the **Mobile Data Initiative** (<http://developer.intel.com/solutions/tech/mdi>) is a cross-industry effort to provide mobile PC users with an easy and affordable wireless connection to data networks, using cellular telephones linked to mobile PCs.

The Mobile Data Initiative unites three exciting technologies. The combination of powerful mobile PCs, digital wireless telephony, and the Internet gives business users new resources that they can leverage while out of the office. With these new products and services, business professionals have fast, reliable and cost-effective access to information wherever their business takes them.

Mobile Data Initiative Technology

What's New:

- **North American MDI Introduced** - press release, August 1997
<http://www.intel.com/pressroom/archive/releases/mp080497.HTM>
- See who the **North American MDI members** are
<http://www.pcsdata.com/participants.htm>
- **History of the MDI**
<http://www.intel.com/mobile/entrprse/mdi.htm>
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

The Mobile Data Initiative (MDI) is an affiliation of leading technology companies including mobile phone network operators, telecommunications vendors, and mobile PC hardware and software manufacturers. Intel established and leads the MDI with a goal of enabling mobile users to stay connected via a simple, cost-effective wireless connection to data networks.

MDI endorses GSM (Global System for Mobile Communications) technology as the best way to exchange data wirelessly today. GSM is secure, reliable, and has the most extensive global coverage of all digital networks. In fact, GSM is used by over 44 million people throughout the world today. PCS1900, an adaptation of the GSM standard for North America, is compatible with GSM networks in Europe and elsewhere around the world. MDI will also endorse other digital wireless telephony technologies as soon as they become business-ready.

Benefits to Users:

Wireless mobile computing completes the business traveler's remote office by making it possible for traveling professionals to stay connected anytime -- anywhere their business takes them.

By simply connecting a digital wireless telephone to a notebook computer, business travelers can remotely gain secure access to all of the resources they have while in the office: e-mail, fax, corporate LAN, and Internet/intranet. So there's no need to wait for FedEx, a hotel fax, or even to locate a phone jack; users have immediate access to data and networks wherever they are, and critical information can be relayed on the spot. The downtime that travelers often experience, whether waiting for a flight, in a cab, or on a train can now be put to productive use through wireless mobile computing.

Best of all, it's easy. The technology leverages notebook PCs and mobile phones, both powerful tools that business travelers already use. So there's no need to learn to use a new device or to carry extra equipment along - the same phone business travelers use to talk can also be used to transmit data.

Benefits to Manufacturers:

Intel continues to spearhead the Mobile Data Initiative by bringing industry leaders together with a commitment to delivering seamless, integrated solutions. Intel held the first North American "PlugFest" in July 1997 to bring together leading manufacturers of notebook PCs, GSM phones, PCMCIA adapter cards, network data services, and software. Intel will continue to provide interoperability workshops for this community, and actively promotes the development of new products and services.

Intel and the MDI are also working to raise the awareness of this technology and its benefits. These efforts are designed to help spur customer demand for all the components of wireless mobile computing solutions: notebook PCs, wireless phones, PCMCIA adapter cards, access to digital wireless networks, and communications software.

Industry Status:

The North American Mobile Data Initiative was launched on August 4, 1997, following a successful European launch earlier in October 1996. The North American MDI currently has 12 core member companies, including the members of the GSM Alliance in the U.S. GSM networks have launched commercial service across the U.S.; voice service is available in nearly half the nation's top 50 metropolitan areas, and data service is coming to most markets soon. GSM networks now serve millions of subscribers worldwide, with a rapidly growing subscriber base in the U.S. Planned coverage will reach virtually the entire U.S. population.

MDI members will continue to introduce products and services that enhance wireless mobile computing throughout 1997 and 1998. Other technologies are currently being evaluated for inclusion in the Mobile Data Initiative.

Next Steps:

If you would like more information about the Mobile Data Initiative -- or would like to participate in the next "PlugFest" interoperability workshop -- please complete a form at one of the following web sites:

In North America, http://www.pcsdata.com/feedback_cgi.html

In Europe, http://gsmdata.com/feedback_cgi.html

For More Information:

To get more information about the MDI effort, visit the **North American MDI web site** (<http://www.pcsdata.com/>).

Or, the **European MDI web site** is at (<http://gsmdata.com>)

Intel's **mobile computing/wireless data communications site** also provides a broader view on wireless mobile computing issues and implementation in the U.S. as well as Europe (<http://www.intel.com/mobile/entrprse/wireles.htm>).

Platforms: (continued)

Server Platforms

What's New

- Intel and Industry Leaders Unveil **Intel-Based Servers with I2O® Technology**
(<http://www.intel.com/pressroom/archive/releases/io100797.HTM>)
- **New 64-Bit Processor** Will Extend the Intel Architecture for Servers -
Joint Intel/HP 64-Bit Instruction Set Disclosed at the Microprocessor Forum
(<http://www.intel.com/pressroom/kits/events/mpf1097.htm>)
- Intel Helps **Reduce Server Downtime** with Enhanced Management Capabilities
(<http://www.intel.com/pressroom/archive/releases/ld100897.HTM>)
- Check Out Intel's **New Server Product Building Blocks**
(<http://developer.intel.com/design/servers/>)
- Intel Shows Paths to **Competitive Business Computing** at Networld+Interop
(<http://www.intel.com/pressroom/archive/releases/nw100797.HTM>)
- **Intel to Acquire Corollary Inc.** a privately held supplier of IA based multiprocessing technology
(<http://www.intel.com/pressroom/archive/releases/SP093097.HTM>)

Overview

Intel architecture has been the engine at the heart of industry-standard, high-volume servers since the first i386™ PC was turned on its side and loaded with Netware®, well over a decade ago. Advances in server platform performance and capabilities since then have primarily been prompted by two fundamental forces: 1) Moore's Law-driven advances in microprocessor performance (please see this month's **feature article** by Gordon Moore (<http://developer.intel.com/solutions/issue/feature/>), and 2) competition and innovation enabled by widely adopted industry standards.

No one today would think of installing a server that didn't contain at least one PCI bus. Many server designs include two, three or more PCI buses for maximum bandwidth and throughput. Increasingly, servers are designed with "smart" peripheral controllers that off-load the main processor from low-level I/O chores. Many different approaches to high availability and scalability using various clustering techniques are now starting to be widely used. Finally, storage subsystems are rapidly evolving from the relatively limited realm of SCSI to the practically unlimited environment of Fibre Channel and intelligent, network-attached storage devices.

The result of all of this technological innovation is more performance at a lower price, with freedom from proprietary lock-in as an added bonus. Intel is focused on four main technology areas to further advance the Standard High-Volume (SHV) server platform:

1) scalability, 2) manageability, 3) I/O, and 4) flexibility.

Scalability

Ask four IT managers what they mean by "scalability," and you will get at least four different answers. To Intel, "scalability" means "never being forced to turn away requests for service due to lack of computer system resources." Intel and the SHV server industry are addressing the scalability challenge in two ways: 1) ongoing, rapid improvements in the performance and throughput of the core electronics complex, including Intel processors and chipsets, and 2) industry-standard, extremely high-performance methods of combining multiple SHV servers together into robust scalability clusters.

The Virtual Interface (VI) Architecture is the critical standard that Intel, Compaq*, and Microsoft*, along with over 100 contributor companies, are promoting for high-performance scalability clusters. Robust, high-performance SHV server building blocks, combined with industry-standard, high-performance

clustering techniques (and the right kind of cluster-enabled database software), allows the construction of very high-performance and high-capacity server systems that are relatively low-cost when compared to proprietary alternatives.

Regardless of the scale of the workload, such systems will almost never have to turn down a request for service. They will exhibit virtually limitless scalability.

Manageability

As part of its **Wired for Management (WfM) Initiative** (<http://developer.intel.com/solutions/tech/wfm>), Intel has recently added a server management section to the WfM Baseline Specification. Currently at a 1.1a revision level, Intel is working with leaders in the server management industry to create a 2.0 version of the WfM specification that addresses more of the manageability requirements that are unique to the SHV server platform.

The goal of WfM for servers is to define a broadly accepted and implemented "baseline" level of instrumentation and management features that are available to all management tools written to the baseline. Intel does not expect to include all of the possible aspects of server management in the baseline. Manageability is a critical competitive differentiator for SHV server makers. Intel expects that to continue. The WfM baseline specification for servers merely creates a "starting point" for server management that should be the minimum expectation for any server to be considered "manageable."

I/O

File and network input/output is the primary thing that servers do, whether the higher-level function they're performing is database, file/print, Internet, e-mail, etc. Server I/O capacity and throughput are crucial to the overall performance and headroom of the server application. Intel has been working for over a decade to improve server I/O subsystem capacity and throughput. From ISA to EISA to PCI, and on to multiple PCI buses in a single server, Intel provided much of the core technology and enabling silicon products that permitted these improvements.

Intel continues to work to advance the capabilities of the SHV server I/O subsystem. In 1998, SHV servers will be able to accommodate next-generation 64-bit PCI cards. Operating at 33MHz, the 64-bit PCI bus in next year's server systems will be able to transfer a peak of 266Mbytes per second, twice today's 133Mbytes. In addition, next year's servers will provide more PCI expansion slots and more PCI buses than today's SHV servers can provide. The result is more I/O capacity and greater peak I/O performance, which will be required in order to keep pace with the much higher performance of the core electronics complex.

But raw performance is only part of the story. The overall system I/O architecture is also a critical element. Historically, SHV servers have used monolithic I/O drivers and controllers. These solutions provide good performance for a single card or I/O function, but they deliver that performance at a significant cost in terms of processor and interrupt load. The net result is often less aggregate performance than the system is theoretically capable of providing. So-called "intelligent" network and disk interface cards have also been long available for SHV servers. These cards incorporate a microprocessor and use specialized drivers to off-load a portion of the I/O or networking functions from the main processor. What's been missing is an **industry standard** that allows every SHV server I/O subsystem to operate in an intelligent fashion.

The **Intelligent I/O (I₂O)** specification (<http://developer.intel.com/solutions/tech/i20.htm>) provides just such an industry standard. It is targeted at resulting in better overall system performance, scalability and headroom, with the added benefit of reducing the amount of validation work required for new cards and drivers.

Flexibility

Today's SHV servers come in all shapes and sizes. Server vendors configure systems to fit specific purposes according to their market focus. Number of expansion slots and chassis designs vary enormously, among other options. There can never be a one-size-fits-all standard for servers. The range of applications and uses is simply too diverse. However, Intel believes that it is both possible and

desirable to create industry standards for selected server modules, such that many different types of final systems can be successfully configured from standards-based building blocks.

Using a common set of building blocks, a system vendor or systems integrator could configure a very large-scale compute server, for example, with many multiprocessing compute nodes in a cluster, and relatively little I/O capacity. A large-scale data-warehouse platform could be constructed from many processor and I/O subsystem building blocks. The common denominators between all of these configurations are industry-standard building-block modules and standards-based, high-performance clustering interconnects.

Expect announcements from Intel and the industry in the near future on standard building-block modules and clustering interconnects.

Virtual Interface (VI) Architecture

What's New:

- SAP and Intel Announce Formation of SAP Intel Center of Expertise:
The center will focus on VI Architecture, IA-64 Optimization, Network/Cluster technologies.
(<http://www.intel.com/pressroom/archive/releases/sp082597.HTM>)
- Oracle and Intel Announced Development Collaboration focused on IA-64 and VI architecture
(<http://www.intel.com/pressroom/archive/releases/sp062397.htm>)
- VI Architecture Initiative to Define High-Speed Communication Interfaces
(<http://www.intel.com/pressroom/archive/releases/sp041697.htm>)
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

Over the last 15 years, high-speed networking hardware has advanced rapidly, with technologies such as ATM, Fast Ethernet and Fiber Channel offering orders-of-magnitude improvements over previous LAN and WAN technologies. On the software side, however, the overhead associated with communicating between the nodes of a large-scale cluster has remained essentially unchanged — until now.

The Virtual Interface (VI) Architecture is an open industry specification designed to facilitate the movement of distributed enterprise applications onto large-scale, high volume, Distributed Message Passing (DMP) clusters. The VI Architecture defines mechanisms for low latency, high bandwidth message passing between interconnected nodes and interconnect storage devices (e.g. clusters). Low latency and sustained high bandwidth are achieved by avoiding intermediate copies of data and bypassing the operating system when sending and receiving messages. Elimination of this overhead not only enables significant communication performance increases, but also results in a significant increase in the number of CPU cycles available for performing other tasks.

Benefits to Users (IT):

The cluster solutions available today depend on the use of non-standard interfaces, software and often hardware, usually running on only one hardware configuration and using one operating system. There is very little investment preservation as hardware and software technologies evolve. The VI Architecture defines a standard interface that allows distributed clustered applications a single hardware/software interface that results in more portable application code as technology advances occur. This portability allows customers to run their most complex enterprise-class applications on affordable, high-volume, open computing clusters whose high availability modularity and reliance on industry standards help reduce Total Cost of Ownership (TCO).

Benefits to Manufacturers:

The VI Architecture allows manufacturers to gain a framework for designing and building low-latency, high-reliability clusters for the volume space. The economies achieved through volume manufacturing of these systems allow clusters to be assembled at a fraction of the price, while surpassing mainframes and supercomputers in both performance and reliability. This fosters the growth of economical, innovative implementations, which offer more value to end users.

Industry Status:

The VI Architecture is in the definition phase, and is being jointly specified by Compaq Computer Corporation*, Intel Corporation and Microsoft Corporation*. Since the original development efforts began in January 1996, more than 100 other industry leaders have joined to endorse the collective endeavor. A preliminary specification of VI Architecture was distributed to participating vendors in January 1997 and a final specification is expected to be released later this year.

Next Steps:

Companies wishing to participate in the VI Architecture specification process should send an e-mail request for details to wire@co.intel.com.

For More Information:

Visit **Intel's Virtual Interface (VI) Architecture information** on the world wide web (<http://www.intel.com/procs/servers/index.htm>). Double click on Industry Alliances for Enterprise Computing.

I₂O Technology**What's New:**

- Industry Server Leaders announce **Intel-based servers with I₂O® technology** (<http://www.intel.com/pressroom/archive/releases/io100797.HTM>)
- Intel's **New I₂O Web site** targeted at IT Managers with lots of good information (<http://www.intel.com/procs/servers/i2otech/>)
- **Detailed I₂O information** and specifications available at the I₂O SIG (<http://www.i2osig.org/>)
- Industry Status (see below)
- What's New (see below)

Technology Description:

The I₂O architecture revolutionizes the concept of intelligent I/O in the light of the new computing industry by providing an industry-accepted specification for the development of intelligent I/O solutions. The two primary objectives of the I₂O specification are to improve system level performance by off-loading the host CPU of I/O tasks, and to enable the general portability of I/O device drivers across operating systems. The I₂O® Architecture is a software specification that provides a standardized framework for the implementation of intelligent I/O subsystems. The concept of intelligent I/O was first introduced in mainframe systems to balance the I/O and compute power of the platform. Special "channel processors" were used to control I/O-specific tasks in these proprietary solutions.

The I₂O specification replaces the standard monolithic device driver with a two-piece driver model composed of the Hardware Device Module (HDM) and the OS Services Module (OSM). The HDM runs on the I/O processor (IOP) and serves as the interface to the target I/O device. The OSM runs on the host processor and serves as the interface to the host operating system. OSMs are developed for each I/O class defined by the specification, and are unique to each operating system. The HDM and OSM communicate over a *messaging layer* using a defined message-passing protocol. This decouples both the underlying bus or interconnect topology and the HDM of the I/O device from the host OS. For a given device, a single HDM can be developed and used with any OS supporting the I₂O specification. This

model also provides the capability for direct communication between HDMs, thereby laying the foundation for peer-to-peer data transfers. In addition, it allows for stackable drivers, providing the capability to add functionality to standard devices, e.g. adding a third party's RAID firmware to any SCSI device driver.

Benefits to IT Community:

The I₂O architecture naturally delivers improved system throughput as a result of incorporating an I/O processor that off-loads the host CPU of substantial I/O tasks. In addition, the I₂O architecture is an essential part of increasing *scalability* in standard, high-volume (SHV) servers. The ultimate goal of scalable platforms is to provide unlimited ability to expand system resources and still produce proportionally greater performance. Once achieved, a scalable environment is clearly a big win for the IT Community.

Another key benefit is the interoperability that the I₂O architecture provides. The split driver functionality of the I₂O architecture will simplify the task of integrating systems and managing the complex environments with multiple OSs and I/O technologies that are typically found in an enterprise.

Benefits to Manufacturers:

The I₂O architecture also brings the benefit of accelerating adoption of new I/O technologies, e.g. ATM, Fast Ethernet and Fiber Channel. By reducing the effort required to develop and maintain device drivers, more resources can be applied to I/O innovation. In addition, less time is spent by OEMs and IT departments testing and validating the multitude of peripheral cards and drivers that are certified with any given platform. Once an HDM is validated to communicate properly with the messaging layer, it is then expected to work with all future versions of any OS that complies with the I₂O specification.

Industry Status:

Member companies are committed to proliferating the benefits of the I₂O architecture and are working together to ensure compliance as well as performance. Intel and other industry IA server vendors announced products supporting the I₂O specification at the October '97 Networld + Interop. A variety of server system vendors are announcing servers with I₂O technology and Intel i960® I/O processors for shipment during the next three months based on Intel Pentium® II and Pentium® Pro processors. These server systems vendors include: Acer America Corp., AST Computer, Compaq Computer Corp., Dell Computer Corp., Gateway 2000, Hewlett-Packard Co., IBM Corp., Micron Electronics, Inc., Mitsubishi Electric PC Division, NEC Computer Systems Division, and NCR.

The development of the I₂O specification is an industry-wide initiative led by the I₂O Special Interest Group (SIG). Originally established in January of 1996 by a group of computer industry vendors (including Intel), it now has an active membership of over 120 companies. For more information on the I₂O Architecture, SIG membership, access to the specification, or developments as an industry initiative, visit the **I₂O SIG web site** (<http://www.i2osig.org/>)

Since the inception of the I₂O SIG® in early 1996, membership in the SIG and product announcements have been growing at a significant rate. The industry saw the first demonstrations of I₂O technology at last year's Fall COMDEX, including demos from server vendors Compaq Computer* and Hewlett-Packard*; storage and networking vendors Adaptec*, 3Com* and Symbios Logic*, as well as OS vendors Microsoft*, Novell* and SCO*. Intel has been playing a major role in the I₂O initiative, providing I₂O architecture building blocks. These solutions include highly integrated I/O Processors (featuring an I₂O architecture messaging unit, PCI-PCI bridge and embedded CPU based on the i960® architecture) and server platforms featuring an Intel IOP and I₂O architecture solutions.

Next Steps:

If you're involved in I/O hardware or software development, join the I₂O SIG and start investing in the technology that your customers will require. The I₂O Specification is available through the I₂O SIG web site, which also provides information on how to become a SIG member and gain access to the on going forums that provide invaluable guidance for your product development decisions.

If you are an IT manager or system administrator, familiarize yourself and your team with the concepts of the I₂O architecture and consult with your equipment providers about how they plan to implement I₂O architecture solutions in their coming products. The vendors who announced products at the October '97 Networld + Interop will be shipping products by January '98 (see **press release**

at <http://www.intel.com/pressroom/archive/releases/io100797.HTM>). The I₂O SIG web site also contains interesting content for non-developers, including vendor announcements, SIG events and industry developments.

For more information:

Visit **Intel's New I₂O web site** targeted at IT managers with lots of good information on I₂O (<http://www.intel.com/procs/servers/i2otech/>).

Visit **Intel's Intelligent I/O Processor web site** for developers including information on Intel's i960[®]RP I/O processor (<http://www.intel.com/design/iio/>).

Visit the **I₂O Industry SIG web site** (<http://www.i2osig.org/>).

Platforms: (continued)

Workstation Platforms

What's New

- **New 64-Bit Processor** Will Extend the Intel Architecture for Workstations—
Joint Intel/HP 64-Bit Instruction Set to Be Disclosed at the Microprocessor Forum
(<http://www.intel.com/pressroom/kits/events/mpf1097.htm>)

Overview

Workstations based on Intel microprocessors have been very competitive at the entry level of the workstation marketplace. They are now demonstrating their power in the midrange and beyond with the **Pentium® II processor** (<http://www.intel.com/businesscomputing/wrkstn/PentiumII/index.htm>) and **Pentium® Pro** (<http://www.intel.com/procs/ppro/wrkstn/index.htm>) microprocessor. That's good news for any company that wants great workstation performance and open system architecture benefits at a fraction of the cost of traditional workstation systems.

Workstation users demand levels of performance that, until recently, could be delivered only by vendors competing on the basis of proprietary, vertically integrated solution "stacks" with little cross-vendor compatibility. Now, that situation is changing. A generation of workstations built around either single or multiple Intel Pentium II or Pentium Pro processors extends the value economics of the PC industry into workstations.

Intel has assembled a team of workstation experts in its new Workstation Products Division (WPD) to supply building blocks, technologies and programs to OEMs, IHVs and software developers to accelerate the development of the Intel architecture workstation market. **System vendors** (http://www.intel.com/procs/ppro/wrkstn/wks_sys.htm) and applications providers alike have been quick to embrace the Pentium II processor's computational muscle and the maturity of Windows NT* for workstation use.

Standard Architecture

The biggest benefit of a single architecture that scales from personal computers to workstations is maximum access to the innovations in both. For users, the new workstation industry provides high performance with outstanding price/performance. It also contributes significantly to lowering the total cost of ownership (TCO) of workstation computing. In essence, more space and convenience to engineering, lower cost per resource to management, lower support costs, and less need for duplicate equipment.

High-Performance

At the heart of the new workstation architecture is Intel's Pentium II processor introduced in May 1997. The Pentium II processor, currently available in frequencies up to 300MHz, delivers the performance required for workstation applications. (For **performance** info please visit <http://www.intel.com/businesscomputing/wrkstn/PentiumII/perf/>)

Over the coming months you will continue to see exciting announcements in the area of workstation advancements based on the Intel architecture. These systems will possess all the key features you have come to expect from an engineering workstation, at an incredible price point:

- High-performance CPU
- Sophisticated 3-D graphics subsystems
- Built-in scalability
- Fast, highly expandable I/O, including advanced networking support
- Configurability to support hundreds of megabytes of RAM and terabytes of disk storage

At the October '97 Microprocessor Forum, Intel announced that the first member of its new family of 64-bit microprocessors, code named Merced™, is scheduled for production in 1999.

The processor still under development will extend the Intel Architecture with new levels of performance and features for servers and workstations. In addition, Merced processors will run all the software that currently operates on 32-bit Intel processor-based workstations. For more information on the Merced announcement, please visit the Intel **press release** (<http://www.intel.com/pressroom/kits/events/mpf1097.htm>).

Complete Solutions

A successful workstation is much more than a powerful processor. Intel is committed to continue working with other companies throughout the industry to ensure that all the technologies and products are in place to deliver optimal workstation solutions based on the Intel architecture.

For more information about **Intel Architecture based workstations**, please visit Intel's Workstation web site (<http://www.intel.com/businesscomputing/wrkstn/index.htm>).

Technologies:

Microprocessor Technology

What's New:

- **New 64-Bit Processor** Will Extend the Intel Architecture—
Joint Intel/HP 64-Bit Instruction Set to Be Disclosed at the Microprocessor Forum
(<http://www.intel.com/pressroom/kits/events/mpf1097.htm>)
- Intel's Pentium® II Processor Hits the Web
Comprehensive **Consumer Marketing & Advertising Campaign** Kicks Off
(<http://www.intel.com/pressroom/archive/releases/CN091697.HTM>)
- Introduction of **New High-Performance, Low-Power Mobile Pentium® Processor** With MMX™
Technology showcasing Intel's 0.25-micron process
(<http://developer.intel.com/design/mobile/>)
- **Pentium® II processors** now available for business, workstation, consumer, and server platforms
(<http://www.intel.com/pentiumII/home.htm>)
- **Dual Independent Bus (DIB) architecture** delivers higher system bandwidth
(<http://www.intel.com/PentiumII/specs/dib.htm>)
- Intel introduces versions of the **Pentium II processor with Error Correction Code (ECC)**
(<http://www.intel.com/pressroom/archive/releases/SP071497.HTM>)
- New **Intel Technology Journal** features in-depth information on Intel's research
& development of key technologies
(<http://developer.intel.com/technology/itj/index.htm>)
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

The Pentium II processor is the most advanced processor with Intel MMX™ technology. Delivering Intel's highest performance on the three vectors of computing—floating point, integer, and multimedia—the Pentium II processor provides ample headroom for applications such as high-end operating systems, business media, PC imaging, communications and more.

The Pentium II processor is available in 233MHz, 266MHz, and 300MHz versions for desktops, workstations and servers. The processor uses the high-performance Dual Independent Bus (DIB) architecture to deliver higher system bandwidth to complement its high processing power. The Single Edge Contact (S.E.C.) cartridge design includes a dedicated 512KB level two (L2) cache. The Pentium II processor also includes 32KB of L1 cache (16K data, 16K instruction), twice that of the Pentium® Pro processor. Error Correction Code (ECC) memory is now available on the L2 cache for added data integrity and reliability, making the Pentium II processor the preferred choice for single and dual processor workgroup and web servers.

For more information visit the **Pentium II processor** home page

(<http://www.intel.com/PentiumII/home.htm>).

Or, for more detailed information please see the Pentium II processor **Technical Fact Sheet**

(<http://www.intel.com/pressroom/archive/releases/dp5797fs.htm>).

Benefits to Users:

Together, systems designed with the Pentium II processor and the **Intel 440LX AGPset**

(<http://developer.intel.com/solutions/tech/aggp.htm>) make multimedia software come alive. Great 3D

graphics, color depth and smooth animation allow for a more lifelike experience for realistic games, educational and hobby software. The Pentium II processor also enables new capabilities in PC imaging, video editing and playback, and audio remixing. Improved video performance also means crisper, clearer images for video playback and editing. Pentium II processor-based systems bring home rich and exciting PC entertainment experiences with new media technologies like **DVD**

(<http://developer.intel.com/solutions/tech/dvd.htm>).

In business, Pentium II processor systems are available for desktop, server and workstation platforms.

The Pentium II processor family is fully compatible with previous generations of Intel Architecture

processors. Both small and large businesses benefit from optimal performance with applications running on advanced operating systems such as Windows* 95, Windows NT* and UNIX*.

On top of its built-in Pentium® Pro processor technology base (Dynamic Execution and DIB architecture), the Pentium II processor takes advantage of software designed for Intel MMX™ technology. This technology enhances full-motion video playback, color depth, and provides more realistic 3D and graphics images, plus offers other media enhancements. Intel is now shipping versions of the Pentium II processor including Error Correction Code (ECC) memory functioning on the level 2 (L2) cache. This type of cache enables servers and workstations to operate in business environments where data integrity and reliability are essential.

At the October '97 Microprocessor Forum, Intel will announce that the first member of its new family of 64-bit microprocessors, code named Merced™, is scheduled for production in 1999. The processor will be produced on Intel's 0.18micron process technology, which is currently under development. The Merced processor will extend the Intel Architecture with new levels of performance and features for servers and workstations. Merced processors will run all the software that currently operates on 32-bit Intel processor-based machines. As IA-64 becomes established with the Merced processor, Intel will continue to expand its 32-bit product offerings. . Larger cache memories, faster buses and continuing increases in core frequencies are among the features of the planned additions to today's Pentium® II processor family slated for release in mid '98. Intel product offerings will then span from 32-bit products for office, home and mobile users to the most powerful 64-bit products which will move Intel into new, higher-end workstations and server market segments. For more information on the Merced announcement, please read the **Intel Merced press release** (<http://www.intel.com/pressroom/archive/releases/sp100997.HTM>).

Benefits to Manufacturers:

Whether you're developing today's most advanced hardware platforms or leading-edge multimedia software, Intel's Pentium II processor brings you Intel's highest performance processor to date allowing you to offer increased performance and capability to business and consumer users. To help you get your own products to market as quickly and reliably as possible, the **Pentium II Processor Developers' web site** (<http://developer.intel.com/design/PentiumII>) offers up-to-the-minute technical information—from product and platform specifications, tools, design guidelines, technology tutorials, related products, and programming and manufacturing support. Check back often for new design information.

Industry Status:

The Pentium II processor family supports the evolution of the PC platform in four important ways:

- 1) Dual Independent Bus architecture
- 2) Dynamic Execution
- 3) Intel MMX™ technology
- 4) Single Edge Contact (S.E.C.) cartridge

These technologies are bringing enhanced performance and capabilities to make visual computing possible on PCs today. Platforms for the business, consumer, workstation, and server market segments are all shipping today. Intel will continue to bring higher performing 32-bit microprocessors and complementary platform building blocks to enhance visual computing capabilities in the future.

Intel's new family of 64-bit microprocessors, code named Merced™, scheduled for production in 1999, will bring new levels of performance and features to new, higher-end server and workstation market segments while continuing to be fully compatible with today's applications running on the 32-bit Intel Architecture.

Next Steps:

Developers: Base your next PC design, whether it is a business desktop, workstation, consumer desktop, or server on the Pentium II processor, and for optimal performance, integrate the Intel 440LX AGPset.

For More Information:

Pentium II processor home page (<http://www.intel.com/PentiumII/home.htm>).

Pentium II processor developer information (<http://developer.intel.com/design/PentiumII/>).

Dual Independent Bus (DIB) Architecture (<http://www.intel.com/pentiumII/SPECS/dib.htm>).

MMX technology (<http://www.intel.com/pentiumII/SPECS/mmx.htm>).

Dynamic Execution (<http://www.intel.com/pentiumII/SPECS/dynamic.htm>).

S.E.C. cartridge packaging (<http://www.intel.com/pentiumII/SPECS/sec.htm>).

Pentium II processor performance (<http://www.intel.com/procs/perf/PentiumII/index.htm>).

Pentium II processor platform technologies
(<http://developer.intel.com/design/pentiumii/platform/index.htm>).

Intel's Merced (IA-64) Announcement Press Release
(<http://www.intel.com/pressroom/archive/releases/sp100997.HTM>).

Memory Technology

What's new:

- Intel makes **100MHz SDRAM Specification** Widely Available
(<http://developer.intel.com/design/pcisets/memory/index.htm>)
- At the Intel Developer Forum on September 30, **Rambus* announced industry support for Direct RDRAM technology** in 1999 and introduced its new RIMM* memory module package
(http://www.rambus.com/html/sep_30__1997.html)
- PC Platform **DRAM Technology Directions**
(<http://developer.intel.com/design/pcisets/rambus.htm>)
- Intel Announces the **Intel 440LX AGPset**
(<http://www.intel.com/pressroom/archive/releases/CS082597.HTM>)
- Intel 440LX AGPset **data sheets** (66MHz SDRAM)
(<http://developer.intel.com/design/agpsets/440/index.htm>)
- Intel 440LXAGPset **design guides**
(<http://developer.intel.com/technology/agp/desguide/index.htm>)
- Industry Status (see below)
- Next Steps (see below)

Technology description:

Intel's goal is to ensure that memory subsystems continue to support evolving platform requirements through 1998 and beyond. Mainstream memory bandwidth requirements will be satisfied by EDO and 66MHz SDRAM performance through the first half of 1998. Intel is also working with memory vendors to keep up with the performance of faster processors and bus architectures. For the past 12 months, Intel has worked with leading DRAM vendors to anticipate this need by developing 100MHz PC SDRAM Component and DIMM specifications. In the second half of 1998, the industry will see an adoption of 100MHz SDRAM to complement new, faster Pentium® II processors. Beginning in 1999, the PC platform will be enhanced by Direct RDRAM to further enhance the interactive lifelike visual experiences on the standard PC platform, including workstation-quality 3D graphics and consumer-quality video.

Benefits to users:

The emergence of 3D and video applications and the evolution of the PC platform to **the Visual Connected PC** (<http://developer.intel.com/solutions/archive/issue1/focus.htm>) keeps evolving the PC architecture. New PC designs that will be based on faster Pentium II processors in mid-'98 are driving the need for ever-higher system memory bandwidth. Intel's leadership and industry participation are delivering new memory technologies which enable the development of higher performance PCs.

Benefits to PC manufacturers:

Continuous work on PC SDRAM specifications helps PC manufacturers showcase platform performance and meet development targets for cost, availability and high-performance features. By working with the industry to develop PC SDRAM and DIMM specifications, Intel is helping to assure that memory products are built to support the next generation of platform requirements. Industry-wide compatibility helps PC OEMs line up multiple compatible DRAM suppliers to meet their cost and availability targets, while providing a high-quality product to PC end users.

Industry status:

Intel's goal is to ensure that memory subsystems continue to support evolving platform requirements and to assure that memory does not become a bottleneck to system performance. It is especially important to

assure that the PC memory roadmap evolves together with the performance roadmaps for the processors, I/O and graphics. To meet this goal, Intel has worked for the past 12 months with leading DRAM vendors to develop 100MHz PC SDRAM Component and DIMM specifications that are now available **on Intel's developer web site** (<http://developer.intel.com/design/pcisets/memory/index.htm>). In addition, Intel participates in ongoing industry dialog to assure that memory suppliers get their technical questions answered.

Intel's role is to work with the memory industry to project future requirements, evaluate technology options, to help choose a path with adequate lead time and then to facilitate communication leading to a complete platform memory solution. This process achieved solid results beginning in 1994, with the introduction of PBSRAM technology for L2 cache. In 1994–1995, EDO DRAM was supported by the Intel 430FX PCIset to achieve major performance improvements on the Pentium® processor. In 1996, the 430VX PCIset supported 66MHz EDO and SDRAM. Intel's newest chipset, the **440LX AGPset** (<http://developer.intel.com/solutions/tech/agp.htm>), supports current platform requirements with 66MHz SDRAM. Intel continues to support the memory industry with system-level simulation tools and design capability to assure OEMs and users have the right products at the right time.

On September 29, Intel held the first Intel Developer Forum focusing on the tools and technical training necessary to implement the latest technologies. Intel provided a Memory technologies track where its top architects discussed 100MHz SDRAM platform implementations for 1998, and Rambus was on hand to discuss Direct RDRAM for 1999.

Next steps:

Intel has delivered the PC SDRAM Component Specification, as well as the Serial Presence Detect and 100MHz DIMM specifications to major vendors and OEMs. These specifications are now available on the Intel developer web site. They provide all the information needed to develop memory modules to support the latest Intel platforms through 1998.

The next step in the memory roadmap is Direct RDRAM. Intel and Rambus are working together to extend Rambus technology to meet PC platform memory requirements for 1999 and beyond. A program and industry status update on Rambus technology was delivered by Intel and Rambus at the Intel Developer Forum on September 30. Rambus also announced that Direct RDRAMs will be packaged in a special memory module called a Rambus inline memory module (RIMM) with dimensions similar to a DIMM. For more details on the Rambus announcement please visit the **Rambus press release** (http://www.rambus.com/html/sep_30_1997.html).

For more information:

Revisit this page often for the latest details on Intel platform support services and future information on Direct RDRAM.

AGP Technology

What's New:

- Intel announces the Intel Performance Evaluation and Analysis Kit (IPEAK), a new line of Performance Analysis Tools including a tool for Graphics and AGP Performance Analysis (<http://developer.intel.com/design/ipeak>)
- First AGP Chipset, the Intel 440LX AGPset, Introduced (<http://www.intel.com/pressroom/archive/releases/CS082597.HTM>)
- Visit Intel's New AGP Web Site for In-Depth Technical Information (<http://developer.intel.com/technology/agp/index.htm>)
- AGP Design Guide Now Available (<http://developer.intel.com/technology/agp/desguide/index.htm>)
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

The Accelerated Graphics Port (AGP) is a new interface on the PC platform that enhances high-performance graphics and full-motion video on mainstream PCs. The AGP interface, positioned between the PC's chipset and graphics controller, enables the graphics controller to use system memory for graphics data (e.g., texture maps) through a dedicated high-speed, low-latency connection. This high-performance capability permits the graphics controller to do texture mapping in a single-step process. Prior to AGP, graphics controllers were required to use a two-step process that involved retrieving texture data from system memory via the PCI bus and storing it in special purpose local graphics memory before it could be used. In short, AGP improves graphics performance two ways. First, with a peak transfer rate of 528MB/s, it greatly increases bandwidth of PCI. Second, it helps to alleviate the cost pressures associated with a growing need for local graphics memory by using system memory instead. In addition, AGP lays a scalable foundation for high-performance graphics—future enhancements will bring its peak bandwidth to over 1GB/s. Not only does AGP improve 3D graphics, but its greater bandwidth is a key enabler for full-motion video on the PC. AGP is implemented with a unique connector for graphics accelerator cards, and requires an AGP-compatible graphics card or chip, chipset, BIOS, and motherboard. The AGP specification has been led by Intel and is open to any and all industry players. AGP is a key element in making Intel's **Visual Computing Initiative** a reality. (See the focus section in Issue 1 of *Platform Solutions* <http://developer.intel.com/solutions/archive/issue1/focus.htm>).

Benefits To Users:

AGP is delivered via Intel's 440LX AGPset in combination with Intel's Pentium® II processor and its Dual Independent Bus (DIB) architecture. In addition to arcade-quality 3D games, consumers can expect entirely new classes of applications to be enabled by AGP, such as 3D reference works and interactive video titles. Business users will also see new types of applications resulting from AGP, such as 3D data visualization and interactive 3D web applications. AGP will also improve the overall performance of the PC. The DIB architecture of the Pentium II processor allows the CPU and the graphics subsystem to work concurrently, thus greatly speeding up the processing done by both. And importantly, by taking graphics and video traffic off the PCI bus, that bus can be used more efficiently by other devices, such as 100 Mb/s network adapter cards.

Benefits To Manufacturers:

AGP takes PCs to a new level of performance. Exciting arcade-quality games and new classes of applications promise to grow the overall market for PCs, peripherals, and software. By providing a dedicated, high-speed pathway between the graphics controller and system memory that matches the processing power of the Pentium II processor, AGP balances the overall performance of the Intel Architecture PC platform. PC OEMs can build systems that more fully realize the potential of the Pentium II processor, and graphics hardware vendors can build products that are no longer constrained by the limited bandwidth of the PCI bus. AGP is a scalable solution so graphics performance will improve in line with performance increases of the Pentium II processor.

Industry Status:

Intel initiated the development of AGP technology and organized the AGP Implementors Forum with industry leaders. The AGP-IF is open to all PC industry players and now has over 130 members, including industry leaders in graphics controllers, systems, and software products. As a result of Intel's leadership, AGP technology has matured and many of these companies are now bringing products to market. In the second half of 1997, PC OEM's will begin offering AGP-enabled systems based upon Intel's Pentium II processor and the Intel 440LX AGPset. A number of other vendors have already announced graphics chips and cards that leverage AGP technology for advanced 3D graphics.

The week of October 7 Intel organized the second AGP Plugfest industry event held in Taiwan. Like the first AGP Plugfest in June, its goal is to ensure full compatibility of industry designs worldwide. The second AGP Plugfest was just as successful as the first one with over 150 developers in attendance testing their AGP platforms and peripherals for compatibility. At the event Intel showcased its **new Intel Performance and Evaluation Kit (IPEAK)** (<http://developer.intel.com/solutions/tech/ipeak.htm>) tools for graphics to be available in Q1'98. The IPEAK Graphics Toolkit currently consists of two tools that help OEMs and IHVs analyze and improve the performance of their graphics solutions. The *Graphics Performance Toolkit* provides a better understanding of the performance issues and limitations related to graphics hardware and applications. And the *Baseline AGP System Evaluation Suite* is a system integration and validation tool that provides the capability to test and evaluate AGP system-level functionality and utilization.

AGP was also covered in the Desktop Graphics and I/O Technologies track at the Intel Developer Forum on September 29. At the IDF, attendees had direct access to Intel's AGP technology architects who trained them on the memory management mechanisms and high-performance usage of AGP as well as performance analysis and tuning using the IPEAK Graphics Toolkit. For an overview of IDF and for future information on the February '98 IDF, please visit the **IDF web site** (<http://developer.intel.com/intel/idf>).

Beyond the hardware platform, numerous entertainment, educational, and business-oriented software applications that take advantage of AGP are under development by industry software vendors. Microsoft* has also announced support for AGP using DirectX* 5.0, Windows* 98, and Windows* NT 5.0. To speed the availability of AGP-enabled systems and software, Intel has made a virtual device driver immediately available to the industry. For information on this driver, please visit the **AGP Implementors Forum web site** (<http://www.agpforum.org/>).

Next Steps:

PC OEMs To deliver high performance PCs to your customers be sure to choose the Intel Pentium II processor and Intel 440LX AGPset. OEMs should start developing AGP systems now in order to take advantage of the surging momentum behind AGP technology.

Graphics chip and card vendors Get AGP-compliant products to market in time for the release of AGP PCs at the end of 1997 and beginning of 1998.

Software developers Now is the time to develop exciting new applications that take advantage of AGP technology. Create apps with rich, lifelike textures to take advantage of the many AGP-enabled PC systems and cards entering the market in late 1997 and early 1998.

For More Information:

Visit Intel's new **AGP home page** (<http://developer.intel.com/technology/agp/index.htm>) for more detailed information on AGP and a tutorial explaining AGP functionality at the system level.

Visit the **AGP Implementors Forum home page** (<http://www.agpforum.org>) for more development, product and event information. There you can find the AGP specification and design guides.

Visit the **Platform Performance Tuning technology page** for more information on Intel's IPEAK Graphics Toolkit to be available in Q1'98 (<http://developer.intel.com/solutions/tech/ipeak.htm>).

DVD Technology

What's New:

- Intel's **DVD White Papers** Provided at the Intel Developer Forum on September 29
Download them Here:
(<http://developer.intel.com/solutions/tech/dvd.htm>):
 - * Copy Protection Licensing Requirements for the CSS DVD Method
 - * Tamper Resistant Software: An Implementation
 - * Implementation of a High-Quality Dolby* Digital Decoder Using MMX(tm) Technology
- Intel to Bring **DVD Movies and Interactive Playback to Mainstream PCs** based on the Pentium® II Processor By Year-End
(<http://www.intel.com/pressroom/archive/releases/CN061997.HTM>)
- Intel-Sponsored **DVD Test and Compatibility Forum** a Success
(<http://www.intel.com/pressroom/archive/releases/DVD80697.HTM>)
- Intel's **DVD Authoring Studio** in Hillsboro, Ore., provides independent software vendors (ISVs) with access to a state-of-the-art DVD authoring facility.
(http://developer.intel.com/drg/hybrid_author/DEVLAB.HTM)
- DVD now a part of the **Open Arcade Architecture**
(<http://developer.intel.com/drg/news/coinop/index.htm#toc>)
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

DVD is a new optical storage technology that stores digital information on discs which are similar in size and appearance to CD-ROMs. DVD discs can contain a combination of audio, video, and computer data, and have been designed for use in both the home entertainment and PC environments. By using 50% smaller "pits" to hold data, a DVD disc can currently hold seven times as much information as a conventional CD-ROM. Future DVD discs will be double-sided and double-layered, allowing four times again as much data to be stored (up to 17GB).

DVD technology has been under development for several years and five different variations have arisen to meet the needs of different types of users:

- **DVD-Video** - Read-only storage intended for the playback of entertainment content, such as movies, on consumer DVD players connected to a TV, or on DVD drives in a PC.
- **DVD-ROM** - Read-only storage intended for PCs. Essentially a much larger CD-ROM. Can store video, audio, images, graphics in any format. Ideal for interactive software such as games, reference materials, and other data intensive applications.
- **DVD-R (Recordable)** - Write-once, read-many storage. The target usage model includes archiving, software development, and low volume data distribution.
- **DVD-RAM** - Write many, read many storage. Example applications include short-term archiving, software development, and media recording.
- **DVD-Audio** - This format focuses on music and other forms of audio-only content. A number of technical issues remain to be resolved, including encoding and copy protection.

Consumer electronics companies are currently producing DVD-Video players to be used primarily for playing movies on televisions. In the PC environment, however, DVD will see a broader array of applications, including interactive titles, archiving, and movies. PC DVD drives are also backwards compatible and will play existing CD-ROM titles and CD audio recordings.

DVD-ROM titles for the PC can be encoded in a variety of different formats (e.g., Indeo® video, MPEG1, MPEG2, Cinepak*), whereas DVD-Video titles for home entertainment are generally restricted to MPEG2 video and AC-3 or Linear PCM audio. The range of encoding formats on PC DVD lends itself to flexible solutions which perform decoding in software rather than with dedicated hardware. PCs based on Intel's Pentium II processor are especially well-suited for software playback of DVD content.

Due to the ease with which digital content can be replicated, copy protection has been an important issue in the development of DVD technology. Intel has worked closely with Hollywood studios and the electronics industry to define copy protection solutions that are suitable for both the consumer electronics and PC industry. Intel has made available a copy protection CSS white paper at the top of this page.

Benefits To Users:

DVD promises to offer consumers a new level of **visual computing**

(<http://developer.intel.com/solutions/archive/issue1/focus.htm>) experience on their PCs. Users can come to expect the following benefits from DVD technology:

- *Huge storage capacity* - Today's applications requiring multiple CD-ROMs (e.g., *WingCommander II**) can be consolidated onto a single DVD-ROM disc.
- *Incredible quality* - With DVD, consumers will be able to experience theater-quality video and audio on their PC.
- *Rich interactivity* - The large capacity of DVDs combined with the processing power of the PC will enable software vendors to create applications that provide visually rich, interactive experiences for end-users.
- *Convergence* - DVD video discs will play on both set-top players and PCs.
- *Backward compatibility* - DVD drives can play existing audio CDs and CD-ROMs.

Benefits To Manufacturers:

DVD technology promises to benefit a wide array of industries and companies. PC OEMs will be able to deliver a more interactive and media-rich experience to end-users. Solutions that use dedicated hardware for playback on PCs are already available. Software providers will be able to create new titles that integrate full-motion video, high-quality audio, graphics, and images. In the near term, they can consolidate multi-CD titles onto a single DVD. Drive manufacturers stand to see increased business as the momentum behind DVD builds and sales of PC DVD drives explode. CD drive and disc manufacturers can leverage their existing manufacturing technology to make DVD products.

Industry Status:

All major consumer electronics companies have released or announced DVD-Video players. Moreover, most major Hollywood studios support the medium and have begun releasing movies on DVD. Several hundred titles will be available for the 1997 holiday season. In the PC market, the first DVD-ROM drives for computers began shipping in April of this year. PC OEMs will be integrating DVD drives into their product lines in the latter half of 1997. Initial PCs will rely on hardware solutions for de-scrambling and decoding functions with the move to more cost-effective software-based solutions in 1998. In addition, the software industry is making a concerted move to DVD-ROM with over 100 interactive titles anticipated by the holiday selling season. The DVD-R and DVD-RAM specifications are complete but products are not yet available. Recently, several companies (Sony*, Phillips*, and Hewlett-Packard*) have announced an alternative format to DVD-RAM called DVD+RW. The DVD-Audio specification is still under development and products are not expected until 1999.

The Intel Developer Forum (IDF) held on September 29 hosted a day-long training track on implementing Host-Based Interactive DVD on the Pentium II processor based PC platform. PC and peripheral developers from around the world received detailed presentations and tools, as well as direct access to Intel's top PC DVD architects. For an overview of the IDF DVD track, visit the **IDF web site** (http://developer.intel.com/intel/idf/abstract/host_dvd.htm). DVD white papers were also provided and are now available for download at the top of this page.

Next Steps:

- *PC OEMs* - Download the new DVD white papers from IDF and become familiar with DVD implementation. Begin to include DVD hardware in your PC designs and start preparing for host-based DVD in your platform designs for 1998.

- **Software Developers** - Start porting multi-CD titles to DVD-ROM. More importantly, begin developing new titles that incorporate full-motion video, high-quality audio, images, and 3D graphics. Visit Intel's DVD Authoring Studio for assistance with getting your title on DVD.
- **Studios** - Continue the transition to the DVD format. Expand the collection of titles on DVD.

For More Information:

Understand DVD's role as a key ingredient of the **PC 98 System Design Guide** just released (<http://developer.intel.com/design/PC98/index.htm>).

Intel's DVD Authoring Studio in Hillsboro, Ore., provides independent software vendors with access to a state-of-the-art DVD authoring facility that allows them to do software layout, testing and pre-mastering of DVD content (http://developer.intel.com/drg/hybrid_author/DEVLAB.HTM).

The **DVD FAQ** is a good source of more detailed information about DVD (<http://www.videodiscovery.com/vdyweb/dvd/dvdfaq.html>).

One stop shopping for DVD information on the Web (<http://www.unik.no/%7Erobert/hifi/dvd/>).

MPEG Organization DVD Resources (<http://www.mpeg.org/~tristan/MPEG/dvd.html>).

PC-CE Convergence web site (<http://www.convergencepoint.com/>).

DVD and Microsoft* O/S web site (<http://www.microsoft.com/hwdev/devdes/dvdwp.htm>).

Stay tuned to this *Platform Solutions* DVD technology page for the latest news around DVD on the PC platform.

Audio Technology

What's New:

- Intel Announces **version 2.0 of Audio Codec '97** (AC '97) specification (<http://developer.intel.com/pc-supply/platform/ac97/>)
- Intel Announces **Audio'98**—Press Release, April 1997 (<http://www.intel.com/pressroom/archive/releases/CN40797C.HTM>)
- **Audio 98 Roadmap** Now Available (<http://developer.intel.com/pc-supply/platform/aud98/audio98.htm>)
- New **USB Audio Application Note** available for download (<http://www.intel.com/design/usb/applnnts/292206.htm>)
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

Increasing processor performance, integration of functionality and external expansion buses are among the major trends currently transforming PC audio. As processor performance increases, more functionality is accomplished in software. This is an industry-wide trend and can be observed across all platforms and CPUs. Hardware faces competition with software-only implementations and needs to demonstrate a functionality, performance or quality advantage. However, for high-performance 3D computing and gaming platforms, hardware acceleration will continue to be desirable. As the attach rate for a function goes up there is more incentive for integration onto the system motherboard or even into the SuperIO or chipset logic. This is also an observable industry trend. External expansion buses offer PC OEMs system design and configuration flexibility, and offer PC customers user-friendly upgrades. The gradual replacement of ISA add-in cards with **USB** (<http://developer.intel.com/solutions/tech/usb.htm>) is under way, and **IEEE 1394** (<http://developer.intel.com/solutions/tech/1394.htm>) is also expected to gain momentum within the next couple of years. The transition to external digital audio is expected to be gradual because initial implementations will probably appear first at the mid- to high-end PCs and cost more than highly integrated motherboard audio solutions. Intel is providing the industry with recommendations and supporting data on hardware vs. software partitioning. Intel is very involved in each of these areas and the Audio '98 roadmap (<http://developer.intel.com/pc-supply/platform/aud98/audio98.htm>) document helps clarify the transitions and what the industry is doing for 1998.

Benefits to Users:

The main benefit to users is that they will get much higher quality audio solutions with several key new features that have not been possible before. 3D positional audio will bring new levels of realism to games with sounds being positioned interactively around the user, making them truly part of the 3D virtual experience. The user will also get much better music reproduction with MIDI utilizing Wavetable synthesis.

Benefits to Manufacturers:

Audio has become a very important and highly visible part of today's PC experience. With the arrival of very high quality built-in audio components and external digital connectivity, the quality of the PC audio experience will rapidly become a function of the PC customer's budget for audio peripherals. The growing diversity of PC audio requirements, platform segments, and buses forces all industry players to acknowledge that there is more than one right way to implement audio. Upcoming operating system releases are expected to fully support external digital audio peripherals and emerging digital consumer electronics connections, increasing system flexibility and scalability on the high end. By 1998, Intel expects digital extensions to the baseline system audio will emerge based on USB and IEEE 1394 specifications: USB for PC audio peripherals, and IEEE 1394 for connections to digital CE. AC '97 and USB (or IEEE 1394) should be viewed as overlapping yet complementary specifications that provide

OEMs with more opportunities to address a wider range of platform implementations. Intel expects that the majority of PCs in 2H98 will support analog connectivity. But in the end, it is the PC OEM who is in the best position to determine whether a SoundBlaster* compatible, Digital-Ready, or Digital-Only audio solution satisfies the customer's needs.

Industry Status:

Intel worked with the industry to develop the original AC'97 specification in 1996. Many new audio products are now shipping that support AC'97. PCI (AC'97) audio products will be shipping in volume in the first half of 1998 time frame. With the introduction of Windows* 98 and WDM audio, USB audio devices will be enabled and shipping. The audio quality that AC '97 provides is a key enabler of **DVD** (<http://developer.intel.com/solutions/tech/dvd.htm>) content, as well as software-driven three dimensional audio technologies such as Intel's recently announced Realistic 3D Sound Experience (RSX) technology. Based on extensive feedback from leading industry audio chip and peripheral vendors, and PC manufacturers, the Audio '98 roadmap highlights the technical ingredients to deliver audiophile-quality audio to the PC.

At the Intel Developer Forum (IDF) Intel released a version 2.0 update to the Audio Codec '97 specification. The new spec is intended to augment the existing AC '97 version 1.03 specification rather than replace it. AC '97 rev. 2.0 defines new extensions supporting high-quality audio (like that from DVD), and extensions for modem and docking to help both desktop and mobile manufacturers adopt these features more quickly and cost-effectively. The specification can be downloaded from the Intel developer **AC 97 web site** (<http://developer.intel.com/pc-supply/platform/ac97/>).

At IDF Intel also discussed the implications of audio implementations with the PC 98 System Design Guide. IDF presentations from Intel's top architects for the PC 98 training tracks are available on **Intel's PC 98 web site** (<http://developer.intel.com/design/pc98/#IDF>).

Next Steps:

OEM's and IHV's: The time has come to start moving away from Legacy ISA audio to new PCI/AC'97 audio for the new features that it will only be able to deliver. All 2H97 products should support PC'97.

E-mail Audio97@intel.com to add your name to the Audio '97 mailing list to receive periodic updates.

Come back to the Audio technology Platform Solutions news page for future information on Audio 98.

For More Information:

For more background information (white papers and specifications) go to **Intel's AC'97 web site** (<http://developer.intel.com/pc-supply/platform/ac97/>).

For technical presentations on audio and other PC 98 training tracks from the September '97 Intel Developer forum visit the **PC 98 site** at (<http://developer.intel.com/design/pc98/#IDF>).

For more information on the **Audio'98 Roadmap** go to (<http://developer.intel.com/pc-supply/platform/aud98/index.htm>).

For more information on USB Audio, download the **USB Audio Application Note** (<http://www.intel.com/design/usb/applnotes/292206.htm>).

USB Technology

What's New:

- **Q&A with Intel's USB experts** in Issue 1 of *Platform Solutions*
(<http://developer.intel.com/solutions/archive/issue1//USB.htm>)
- **First Wave of USB Products Arriving on the Market**
(http://developer.intel.com/design/usb/new_pcs.htm)
- **New USB Mobile Design Guide** Available for Download
(<http://test.intel.com/design/usb/designex/usbg10.htm>)
- **New USB Audio Application Note** Available for Download
(<http://developer.intel.com/design/usb/applnnts/292206.htm>)
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

Universal Serial Bus (USB) is the easier to use and flexible interconnect specification that enables instant "outside the box" Plug and Play peripheral connectivity. It allows users to add peripheral devices without expensive add-in cards or configuration headaches such as DIP switches and IRQ settings. A single connector type simplifies connection of all USB-compliant devices, including telephony peripherals, video phones, digital cameras, scanners and monitors in addition to joysticks, keyboards and other I/O peripherals. USB's hot attach/detach capability lets users add and remove devices without turning off their PC. USB also distributes power to peripheral devices and employs a hub architecture that allows as many as 127 different devices to be connected simultaneously.

USB is a key enabling technology for emerging PC initiatives including PC Imaging and Computer Telephony Integration (CTI). Moreover, the connectivity needed to **support Intel's Visual Computing initiative** (<http://developer.intel.com/solutions/archive/issue1/focus.htm>) may now be attained without the need for add-in card solutions.

For more details, visit **Intel's USB home page** (<http://www.intel.com/design/usb/>).

Benefits to Users:

USB expands the PC experience by enabling a new dimension of configuration freedom and interactivity. The absence of add-in cards and power supplies also helps reduce overall system cost. USB is easier to use and allows users to instantly reconfigure their systems "on the fly" by plugging and unplugging devices. Because USB enables both isochronous and asynchronous data transfers, it has the capacity to enrich the user's ability to control peripherals, such as audio speakers, from the PC. The ease of device sharing makes PCs more manageable for users of home and business PCs.

Benefits to Manufacturers:

USB is an open, royalty-free specification which has received broad industry acceptance. USB's ease of use and relatively low cost are expected to support the continued expansion of the PC peripherals market into new and fast-growing areas such as digital imaging, integrated telephony and interactive multi-player games. Absence of add-in cards and, in many cases, external power supplies also simplifies product design and helps reduce costs. Fast time-to-market development solutions are available now from Intel and other suppliers.

Industry Status:

USB technology is in full-swing implementation. Most new PCs introduced in 1997 are shipping with live USB ports, ready to connect to USB-compliant devices. Many USB devices are now arriving on the market, and hundreds of USB peripheral products are slated for release in 1997 and 1998.

Next Steps:

Peripheral Developers—Once they get their hands on USB, PC users may never let go. Now is the time to develop USB-compliant products, so you will be ready to meet this growing level of consumer awareness.

System Developers—Designing with PCIsets that support USB and the OEM release of Windows* 95 will help position you to meet the anticipated consumer demand for "device-ready" USB-compliant PCs. Be sure to visit Intel's USB home page and the USB Implementers Forum home page for the design information, developer support and product information you need.

For More Information:

Q&A with Intel's USB experts, Steve Whalley and Bala Cadambi, in Issue 1 of Platform Solutions (<http://developer.intel.com/solutions/archive/issue1/stories/USB.htm>).

See Intel's USB home page for the **latest developer resources and design tools** (<http://www.intel.com/design/usb/>).

Visit the USB Implementers Forum home page for information on **development support, products and events** (<http://www.usb.org>).

1394 Technology

What's new:

Presentations given at the 1394 Trade Association Developers Conference held at the Fairmont in San Jose, California in July 1997:

- Intel presents its **commitment to 1394**
(<http://developer.intel.com/solutions/tech/1394.htm>)
- Intel describes its proposal for **digital content protection over 1394**
(<http://developer.intel.com/solutions/tech/1394.htm>)
- Industry Status (see below)
- Next Steps (see below)

Technology description:

IEEE 1394 is a video-speed serial interconnect that is now an IEEE standard. Like USB, 1394 enables plug-and-play peripheral connectivity, provides power to peripherals helping to eliminate each one having its own power supply, and supports isochronous data transfers. 1394, however, takes these capabilities to video speeds. USB and 1394 serve different needs which will remain and coexist for the foreseeable future. Peripherals that do not require the high data transfer rates possible with 1394 will remain with USB. Eventually, PCs will need only USB and 1394 serial ports to handle all I/O, dramatically simplifying life for PC users.

The consumer electronics industry is already shipping digital camcorders, digital still image cameras, digital satellite receivers, and digital VCRs all with 1394 interfaces. 1394 is the physical bridge that makes the convergence of consumer electronics and personal computers possible. Existing products support 1394 protocols at 100 and 200 Mbps, with 400 Mbps products shipping in 1998. The 1394 road map extends to speeds at 800, 1600, and 3200 Mbps.

1394 also provides the storage industry with a PC interconnect to follow on IDE and the printer industry to replace the parallel port. Because 1394 can handle very high data rates, it encourages peripherals to transmit more "raw" data to the PC for host-based processing, which can significantly reduce the cost of some peripherals like digital still cameras. 1394 is important not only for connectivity to new digital consumer electronics devices, but also for core PC peripherals as they move to higher data rates.

In conjunction with USB, 1394 makes possible new "modular" approaches to PC architecture with the modules tied together with two serial buses. The proposed Device Bay specification (<http://www.device-bay.org/>) is an excellent example of the great new applications enabled by 1394 (and USB), in this case providing peripheral modularity.

Benefits to Users:

One promise of 1394 is a significantly enriched PC user experience. Users will be able to use their PCs to control consumer electronics and PC peripherals, edit audio/video content, link peripherals to the internet, and much more. 1394 will bring the PC to the family room to provide entertainment, gaming, and learning experiences not possible today.

Modular PCs will allow users to buy as little or as much PC as they like and to upgrade their PCs selectively, at will and painlessly. A personal computer system becomes more like a component stereo system, with 1394 playing the role of a digital RCA connector.

Benefits to Manufacturers:

Because it is plug and play, 1394 confers all the same benefits as USB to manufacturers in terms of ease-of-use and reduced customer support requirements. The user never needs to open the box. Because 1394 enables users ready access to rich digital content, it will make the PC more attractive, thereby driving revenues. The modularity offered by 1394 (in conjunction with USB) offers PC manufacturers a greatly simplified manufacturing process and lower inventories in both the factory and in the field. Peripheral manufacturers benefit from compliance to a single industry standard supported by both the consumer electronics and computer industries, allowing in many cases the same SKU to be sold into both markets.

Industry Status:

IEEE 1394.1995 is in production today in consumer electronics equipment. An enhancement, called 1394.A, is expected to go to the IEEE for balloting in 1997. The industry is actively working on closing the definition of 1394.B, which will define 1394 at speeds of 800 Mbps and beyond. Intel expects some 1394-enabled PCs to be available by the end of 1997 and processor chipsets supporting the 1394 Open Host Controller Interface to be available in 1998.

The transfer of copy protected video is a very hot topic and important to the movie industry. Intel has proposed a digital content protection method to the 1394 Trade Association that is available now for review.

Next Steps:

PC systems vendors and peripheral manufacturers: make plans now to support 1394 ports on your future systems if you haven't already. Everyone, including consumer electronics manufacturers: insure your 1394 interfaces are defined in compliance with the IEEE specifications and 1394 Trade Association guidelines to ensure interoperability.

For More Information:

Contact the **1394 Trade Association** site for more information on 1394 and links to many other 1394-related sites (<http://www.1394ta.org>).

Power Management Technology

What's New:

- Intel power management architect Gary Solomon describes the ins and outs of the **new Instantly Available PC** in Issue 2 of *Platform Solutions*
(<http://developer.intel.com/solutions/issue/stories/iapc.htm>)
- Just Released; the **Instantly Available PC Power Management Design Guide**
(<http://developer.intel.com/design/power/pcpower.htm>)
- **Power Supply '98 Introduced**—New Dual Mode Power Supply Specification (press release)
(<http://www.intel.com/pressroom/archive/releases/CN92997A.HTM>)
- Download the latest **Power Supply '98 Specification**
(<http://developer.intel.com/design/power/supply98.htm>)
- A Complete List of **Power Management Specifications** for the Instantly Available PC
(<http://developer.intel.com/ial/powermgm/specs.htm>)
- **PCI-Power Management Specification** Available for Download
(<http://www.pcisig.com/pm10.pdf>)
- Intel Announces the **Mobile Power Initiative and Mobile Power Guidelines** targeted at special considerations for achieving ultimate power efficiency in Mobile PCs.
(<http://developer.intel.com/design/mobile/intelpower/>)
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

The Instantly Available power-managed PC is a new way of viewing power management requirements for today's fully featured home or office PC. The goal of the Instantly Available PC is to have a high-performance, feature-rich PC that is power efficient when active and idle, always connected even when "off," and "instantly available" to users whenever needed. The Instantly Available PC is made up of several industry standard ingredients:

- ACPI (Advance Configuration and Power Interface) provides a standard yet flexible interface between hardware and applications to communicate their power management capabilities to the operating system.
- PCI-PM (PCI Power Management) allows add-in cards to participate in the overall power management scheme and introduce a new methodology to the scheme as well.
- Power Supply '98, a Dual Mode Power Supply that will provide clean and intelligent power delivery under both heavy and light loads.
- An ACPI enabled OS will combine the above ingredients to create an intelligent power management platform.

Benefits To Users:

Because of the Instantly Available PC, home users will experience a PC that behaves much like a consumer electronics device. When it is not active, it appears to be off—there is no noise, no heat and very low power consumption. With the ability to be connected to external consumer electronic devices via **USB** (<http://developer.intel.com/solutions/tech/usb.htm>) and **1394** (<http://developer.intel.com/solutions/tech/usb.htm>) ports, the Instantly Available PC will be the hub of the entertainment center. For example, when you insert your DVD movie, your PC would wake itself up and send the decoded video and audio signals to your ACPI compliant TV and amplifiers after it woke them up too. The Instantly Available PC will deliver a whole new level of usability and robustness, giving us new capabilities for the PC platform touching multiple aspects of everyday life.

For the office PC, the Instantly Available PC has additional benefits with the ability to resume on a LAN event. Intel's **Wired for Management initiative** (<http://developer.intel.com/solutions/tech/wfm.htm>) specifies remote wake-up policies and procedures to help IT lower the TCO (Total Cost of Ownership). These can be implemented with the Instantly Available PC. No longer will IT managers have to worry about a PC being turned off and unable to get a software update packet at night. Energy savings due to power management are apparent, but your cooling cost throughout the entire campus will be lowered too.

Benefits To Manufacturers:

The Instantly Available PC combines an industry set of standard power management specifications that peripheral vendors and PC OEMs can develop products around. This ensures that all products will correctly work with each other and will be able to fully take advantage of the system power management scheme. By adhering to industry-established standards for power management, PC OEMs and peripheral vendors will not have to bear any additional R&D cost associated with developing an Instantly Available system or peripherals. By broadening the PC platform's capabilities we open the door up for different products that we can connect to the PC and enhance the users' experience.

Industry Status:

Intel, Toshiba*, Microsoft* and many other PC manufacturers are working on bringing ACPI platforms and peripherals to the PC community by the end of 1997. Microsoft has announced that its next versions of Windows* 95 and Windows NT* will be fully ACPI compatible. Most PC and peripheral manufacturers should provide full ACPI implementations by the third quarter of 1998. PCI-PM is now available from the PCI industry special interest group.

On September 29, 1997, Intel hosted a full day Power Management technology training track at the Intel Developer Forum. Attendees received one-on-one access to Intel architects, a complete collateral package of specifications, tools, and design guides necessary to implement an Instantly Available PC. Look for the next Intel Developer Forum for the best training on implementing the hottest technologies driving the PC platform today.

Intel also recently announced the Mobile Power Initiative targeted at achieving power efficiency for Mobile PCs in the 1999 timeframe. Not only has Intel recently announced the Pentium® processor with MMX™ technology at 233MHz to increase performance by 40% and decrease power usage by 50%, it has introduced the Mobile Power Initiative to focus on System Hardware, System Software, and Application Software. The new Mobile Power Guidelines (revision 0.80) are available for download at (<http://developer.intel.com/design/mobile/intelpower/>). It's not too late to provide input to the guidelines prior to revision 1.0.

Next Steps:

Peripheral Developers and OEMs should become familiar with the key ingredients for the Instantly Available PC. Download and understand the specifications for each. Available now for download at (<http://www.teleport.com/~acpi>) is the specification for ACPI, and the PCI-PM specification is available at (<http://www.pcisig.com/pm10.pdf>). All the other necessary specifications for implementing an Instantly Available PC can be downloaded at Intel's **PM spec site** (<http://developer.intel.com/ial/powermgm/specs.htm>).

For Mobile PCs, you should become familiar with the Mobile Power Initiative and Mobile Power Guidelines to start designing for ultimate power efficiency in your next designs.

For More Information:

The **Instantly Available PC Power Management Design Guide**
(<http://developer.intel.com/design/power/pcpower.htm>).

Get the latest Power Supply '98 **Dual Mode Power Supply specification**
(<http://developer.intel.com/design/power/supply98.htm>).

For a **closer look at ACPI** (<http://www.teleport.com/~acpi>).

A Complete list of **downloadable Power Management Specifications** for the Instantly Available PC
(<http://developer.intel.com/ial/powermgm/specs.htm>).

The **Mobile Power Initiative and Mobile Power Guidelines** designed to increase power efficiency in
Mobile PCs (<http://developer.intel.com/design/mobile/intelpower/>).

PC 98 Technology

What's New:

- **PC 98 System Design Guide 1.0**, co-authored by Intel Corporation and Microsoft Corporation*
Released to the Industry
(<http://developer.intel.com/design/pc98/index.htm> or <http://microsoft.com/hwdev/pc98.htm>)
- Intel provides a day's worth of technical training on implementing PC 98 at the **first Intel Developer Forum** on October 1, 1997. To view all of the PC 98 IDF presentation visit the PC 98 Web Site
(<http://developer.intel.com/design/pc98/#IDF>)
- PC 98: **Keeping the PC Platform Balanced**; Read an overview of three key technology implications of PC 98 by John Hyde, Intel's PC 98 Architect and Design Guide Editor
(<http://developer.intel.com/solutions/issue/stories/top5.htm>)
- **Leading the Way to PC 98**; Read an overview of PC 98 and Intel's role by Jim Pappas, Director of Platform Initiatives at Intel from Issue 1 of Platform Solutions
(<http://developer.intel.com/solutions/archive/issue1/stories/pc98.htm>)
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

The PC 98 System Design Guide describes and recommends how a range of PC platforms should be designed to enhance user experience and satisfaction. PC 98 covers mobile PCs, business and consumer PCs, entertainment PCs and workstations that will ship from mid-1998 through 1999. Hand-held devices running Windows CE and servers are not included in the PC 98 document.

The Design Guide is divided into four parts. Part 1 covers upcoming technologies that will be available in the 1998 and 1999 timeframes. Part 2 contains a rigorous description of System Types—most of this section describes a Basic PC 98 from which a Business, Consumer or SOHO (Small Office Home Office) desktop can be derived; two styles of Entertainment PCs, a two-foot viewing experience and a 10-foot viewing experience are described. Mobile design considerations are covered in a separate chapter, as are workstation design issues. Part 3 describes expansion bus options such as USB, IEEE 1394, PCI, SCSI and other industry specifications. Part 4 details how add-in and add-on devices should be designed; many new technologies and specifications are introduced in this section.

Benefits to Users:

PC 98 describes the introduction of new technologies into PC designs that are becoming more tailored for specific uses in the business and consumer markets. These new technologies and platform designs are intended to increase the utility and ease of use of the PC for different kinds of tasks and offer more choices to businesses and consumers. The overall goal of PC 98 is to address the expanding uses and users of PC technology and to enhance the user experience and satisfaction.

By writing this document together, Intel and Microsoft are ensuring that the enabling hardware and supporting software will be available at the same time. The lead time for new hardware designs and for software device drivers is being overlapped to shorten the time to a working, available solution. This up-front cooperation and planning will result in a better user experience.

Benefits to Manufacturers:

Introducing multiple new technologies into the existing PC platform infrastructure could create numerous problems. By working together and with industry experts, Intel and Microsoft have identified a variety of solutions and are creating new industry specifications, or supporting existing industry specifications, to ease rapid and successful absorption of these new technologies. By driving open specifications, Intel can also encourage innovation throughout the multiple PC platform design choices.

Industry Status:

Intel has been a behind-the-scenes contributor on previous versions of the PC 98 design guide. Due to the many projects Intel has on going to introduce new hardware technologies and increase ease of use and end-user satisfaction of PC hardware, Intel's involvement in PC 98 has been growing. It was only fitting that Intel co-author with Microsoft on PC 98. Intel and Microsoft have both worked with the industry since February 1997 to review and improve the PC 98 System Design Guide in order to reach a releasable version.

Version 1.0 of the PC 98 System Design Guide was released to the industry in September 1997 and is now available for download from Intel's and Microsoft's web sites at <http://developer.intel.com/design/pc98/index.htm> or <http://microsoft.com/hwdev/pc98.htm>.

On October 1, 1997, Intel hosted a full day technical training for hardware developers on PC 98 implementation at the Intel Developer Forum. Intel's top architects spoke about three key implications for PC 98 hardware implementation: removal of the ISA Bus, Audio, and Graphics. Microsoft was also on hand to discuss Driver Quality. To view all of the PC 98 IDF presentations, please visit the **PC 98 web site** (<http://developer.intel.com/design/pc98/#IDF>).

Next Steps:

If you are currently designing PCs or peripherals for shipment after June 1998 and throughout 1999, the PC 98 System Design Guide is a "must-have" reference. It contains definitive information on the evolution of the PC platform, together with essential information for developers. Visit Intel's developer site for your copy.

For More Information:

Intel's developer web site also contains detailed design information on all aspects of PC design (<http://developer.intel.com>).

Read an overview of three key technology implications of PC 98 in "**PC 98: Keeping the PC Platform Balanced**," by John Hyde, Intel's PC 98 Architect and Design Guide Editor in Issue 2 of *Platform Solutions* (<http://developer.intel.com/solutions/issue/stories/top5.htm>).

Read an overview of PC 98 and Intel's role in **Leading the Way to PC 98**, by Jim Pappas, Director of Platform Initiatives at Intel from Issue 1 of *Platform Solutions* (<http://developer.intel.com/solutions/archive/issue1/stories/pc98.htm>).

See the other **Platform Solutions** pages (Platforms and Technologies) for the latest news and information on PC technologies found in PC 98.

Platform Performance Tuning Technology

What's New:

- Intel announces **platform tools** to help PC OEMs and IHVs shorten development time and improve product performance
(<http://www.intel.com/pressroom/archive/releases/cn92997b.htm>)
- **New Intel Performance Evaluation and Analysis Kit (IPEAK)** web site available
(<http://developer.intel.com/design/ipeak/>)
- Matt Gordon, Intel IHV Ingredient Marketing Manager, fully describes Intel's **new performance tools** in *Platform Solutions*—Issue 2
(<http://developer.intel.com/solutions/issue/stories/top3.htm>)
- Industry Status (see below)
- Next Steps (see below)

Technology Description:

One of the principal barriers historically confronting PC OEMs and IHVs has been a general lack of performance tools designed to accelerate their hardware development efforts. For the most part, development tools for performance optimization and design analysis are typically developed internally by the OEMs themselves. In order to accelerate new platform technology adoption and optimize new platform technology performance, Intel is sharing the results of its R&D efforts and making available a new line of development tools, previously used internally by Intel engineers and architects, to the broad PC industry.

At the Intel Developer Forum on September 29, Intel announced the new family of performance evaluation and analysis tools called the Intel Performance Evaluation and Analysis Kit (IPEAK) to be available in Q1 1998. IPEAK tools help ease technology adoption and platform performance tuning for PC OEMs and Independent Hardware Vendors (IHVs). As the first offerings of their kind in the industry, the IPEAK tools help shorten product time-to-market cycles when adopting new platform technologies and standards. The tools also provide automated testing solutions that reduce the time spent on testing during the system validation process.

The new IPEAK offerings include the Intel Power Management Analysis Toolkit, the IPEAK Storage Toolkit and the IPEAK Graphics Toolkit:

The Intel Power Management Analysis Toolkit (IPMAT) has been developed to help PC OEMs and IHVs incorporate the Advanced Configuration and Power Interface (ACPI) power management initiative in their product design and system integration processes. It also helps to qualify power management functionality, quantify power consumption and test the behavior of applications that incorporate Global System Power Management functionality.

The IPEAK Storage Toolkit consists of four tools—*RankDisk*, *AnalyzeDisk*, *Win32 Tracking Kit*, and *AnalyzeTrace*—that have been developed to help vendors identify optimal storage performance at low cost in product designs. In addition, these tools help PC OEMs and IHVs to select the best possible performance storage products at the same price point.

The IPEAK Graphics Toolkit includes two tools. The *Graphics Performance Toolkit* provides a better understanding of the performance issues and limitations related to graphics hardware and applications. And the *Baseline AGP System Evaluation Suite* is a system integration and validation tool that provides the capability to test and evaluate AGP system-level functionality and utilization.

Benefits to Manufacturers:

The new Intel IPEAK toolkits make it easier for OEMs and IHVs to understand performance issues and limitations that can be addressed in the design process to optimize product performance. For example, IHVs can use these tools to detect any performance pitfalls and make corrections while in the pre-production stage, thus lowering the risk of accruing additional costs and delays in their product shipment schedules.

Benefits to Users:

In addition to the benefits they provide for manufacturers, the IPEAK tools will help Information Technology (IT) managers to evaluate and select products with increased performance when engaged in system integration activities, or when making decisions related to hardware configuration. Equally significant, the tools benefit users by ensuring that the PCs they purchase have been configured in ways that optimize their performance, functionality and reliability. End users will fully realize the performance capabilities of new processors, including the Pentium® II processor, combined with new platform technologies.

Industry Status:

In the past, performance and evaluation tools such as those found in the IPEAK toolkits have not been generally available. With the introduction of the IPEAK tools at the Intel Developer Forum (IDF), Intel has become the first company to provide these specific kinds of platform performance and integration tools for PC OEMs and IHVs. Beta versions of the toolkits were distributed to IDF attendees, with general availability slated for Q1 1998.

Next Steps:

Intel will be monitoring feedback regarding the IPEAK tools from users who were provided with beta versions of the toolkits at IDF. PC OEMs and IHVs who did not attend IDF can get up to speed on the new IPEAK offerings by accessing information available on the new IPEAK web site, and by continuing to check regular status updates that will be posted on this news page in *Platform Solutions* every month.

If you would like to be considered part of the beta program and receive pre-release versions of the tools, please send an email to ipeak@intel.com.

For More Information:

Please check out the new **IPEAK web site** (<http://developer.intel.com/design/ipeak/>).

Read the Top Story, ***Introducing Intel Platform Performance Tools***, by Matt Gordon—Intel IHV Ingredient Marketing Manager—in Issue 2 of *Platform Solutions* (<http://developer.intel.com/solutions/issue/stories/top3.htm>).

Industry Events:

Intel at Power 97

October 12-15, Santa Clara, CA

Fifth international conference on power requirements for mobile computing and wireless communications. Steve Nachtsheim, Intel's Vice President and General Manager of Mobile and Handheld Products Group, will provide the opening keynote.

Contact: Mara Friedman at 617-792-2612 for more information or go to <http://www.gigaweb.com/events/>

Intel at Microprocessor Forum

October 13-16, San Jose, CA

At this year's Microprocessor Forum Intel Corporation will present technical briefings on future IA-32 technologies and give a first glimpse of IA-64 technologies, including the first member of its new family of 64-bit microprocessors, code named Merced™, scheduled for production in 1999. Intel experts will give four presentations on Oct. 14 at the Fairmont Hotel. For more information on Intel's presentations please visit the Intel press room at <http://www.intel.com/pressroom/archive/alert/sp101097.HTM>

DVD Developer Conference

October 29-30, San Jose, CA

Intel Corporation and the Software Publishers Association invite you to attend the DVD Developer Conference entitled 'DVD on the PC: Tools, Resources & Solutions'. This two-day forum is designed to present the latest in DVD information including expert sessions, demonstrations, and workshops. The agenda includes everything from DVD on the PC, MPEG-2 Technology Issues, DVD Security, DVD-ROM Compatibility, Developer Case Studies, to PC DVD Authoring Tools, DVD Replication/Distribution, and Compatibility Testing. The SPA's various Technical Working Groups (TWGs) will also provide an update on the latest DVD Developments. Demonstrations are also planned by leading PC authoring tool providers, hardware companies, and content developers. Key members of each DVD segment are encouraged to attend, including product development, engineering, marketing, and distribution. ISVs, IHVs, OEMs, Hollywood Studios, Toolkit providers, encoders and system manufacturers will benefit from this indepth, hands-on, developer-focused event. For more information and registration information please visit <http://www.spa.org/dvd/dvdconf.htm>

Intel at Fall Comdex

November 17-20, Las Vegas, NV

Intel will be exhibiting on the main show floor and demonstrating the latest Pentium® II processor platform and technology ingredients for the home and small/large business environments. Intel speakers will participate in various panels and sessions. Also, don't miss the Intel BunnyPeople(TM) performing live at the main show floor.

For more information visit the Comdex web site at <http://www.comdex.com>

Intel at Internet World

December 8-12, 1997, New York, NY

Intel will demonstrate all of the areas supporting the growing Internet application area, from client desktop and servers using Pentium II processors, to software applications to networking solutions.

Intel speakers will participate in panels and discussions on the Internet, E-commerce, and telephony.

For more information visit <http://events.internet.com/fall97.html>

Intel Developer Forum

February 17-19, San Jose, CA

Second Bi-Annual hardware developer event hosted by Intel. This is the premier hardware developer event in the industry. Get implementation tools, detailed training and knowledge directly from Intel's top architects and engineers on the latest technologies driving the PC platform - from the Desktop, to Mobile and Server platforms. Stay tuned to Platform Solutions newsletter and the IDF web site for more details on the hot technology training tracks to be offered at the February IDF. To find out what attendees gained at the September IDF, read the Top Stories in Issue 2 of Platform Solutions or visit the IDF web site now at <http://developer.intel.com/intel/idf>

Intel Networking Events & Training

For Intel's events and training programs on Networking products and technologies, please visit the Intel networking events page at: <http://www.intel.com/network/events/index.htm>

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